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~~MINUTES OF PROCEEDINGS~~

The Journal

OF THE

ROYAL ARTILLERY. ~~INSTITUTION.~~

VOLUME I.

WOOLWICH:

PRINTED AT THE ROYAL ARTILLERY INSTITUTION.

M.DCCC.LVIII.

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PREFACE TO VOLUME I.

THERE are many old members of the Regimental Institution to whom it will be grateful to recal the ardent hopes and the warm encouragement with which it was launched, twenty years ago. Short as that space of time appears in the retrospect, it has removed most of its then most influential friends, and has recruited its ranks with more than five hundred members who have no personal recollection of the circumstances which led to its origin. The completion of a first volume of Proceedings appears therefore a fit occasion to place some of those circumstances on record, and to do honor to those distinguished Officers—Sir Hussey, afterwards Lord Vivian, Master-General of the Ordnance, Major-General Sir Alexander Dickson, Deputy-Adjutant-General, Lieut.-General Lord Bloomfield, and others, who extended the hand of encouragement to their juniors at that critical period, and fostered this useful establishment into life.

The immediate origin of the Regimental Institution, was the following paper (No. 1) which was drawn up by two Subalterns of the Regiment, and sent on their private responsibility to a number of the superior Officers then at Woolwich for their concurrence, in February 1838.

No. 2 is the answer of the late Major-General, then Colonel Cockburn, the first President of the Committee, whose large and liberal mind was among the first to perceive the benefits such a plan, realized under competent guidance, must confer on the Regiment; and to whose steady, cordial, unwavering support, its execution is eminently due.

No. 3 is Colonel Cockburn's letter to the Commandant Sir Joseph Maclean.

No. 4 Sir Joseph Maclean's letter to the Deputy-Adjutant-General of Artillery.

No. 5 The Deputy-Adjutant-General's letter to the Master-General of the Ordnance, with Sir Hussey Vivian's Minute.

No. 6. The Regimental Order announcing the formation of the first committee which consisted of

Colonel J. COCKBURN, R.A.
Colonel T. PATTERSON, R.A.
Captain J. BLOOMFIELD, R.H.A.
Lieut. F. EARDLEY-WILMOT, R.H.A.
Lieut. LEFROY, R.A.

No. 7. Report of the Committee, dated 8th May, 1838.

No. 8. Letter from Sir Alexander Dickson, dated 16th May, 1838.

No. 9. Report of Lord Bloomfield, dated 9th June, 1838.

No. 10. Minute by the Master-General, &c.

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(No. 1)

Copy of Original Proposal.

Woolwich, February 1st, 1838.

An application has recently been made to the Lieut.-Governor of the Royal Military Academy, for permission for Officers of the Regiment to make use of the Surveying and other Instruments belonging to that Institution, during the Cadets vacation, * for their own instruction. The inconveniences which might have arisen from this permission prevented Major-General Drummond from acceding to the request.

Individual Officers have at present very little opportunity of improving themselves, in several practical branches of military knowledge, owing, in some measure, to the expensive nature of the instruments required. Considering, however, how large a proportion of the Regiment is constantly present at Head-Quarters, and how many young Officers pass the first year or two of their service in this garrison, it is thought that objects so strictly professional might be attained by other means, than by the limited advantages which would have been afforded had the above application been successful.

With this view the following outline of a plan has been drawn up: its development must depend in a great degree on the support given to it by the Officers of the Regiment generally; if that support be as great as it is hoped and confidently expected it will be, extensive as the proposals may appear, they are perfectly practicable:—

(1.) It is proposed to raise a sum of money by subscription, and to establish a Fund for the purchase, for the use of Officers of the Regiment, of all the Instruments, &c., &c., which are necessary for the study of Military, Artillery, and general Science.

(2.) The Subscription proposed is 10s. per annum for 2nd Lieutenants, and £1 for all other Officers; Donations of Money, Books, or Instruments will also be very thankfully received, in aid of this object.

(3.) The money will be received and the arrangements conducted, in the first instance, by a Committee of Subscribers.

(4.) The Committee will make application to the Hon. Board of Ordnance to give a Site in the neighbourhood of the Barracks, and to permit the erection of a small Building, to consist of an Observatory calculated for the reception of a few of the most useful permanent Astronomical Instruments; a room fitted up for General Apparatus, Portable Instruments, Globes, &c., &c.; a room for the use of the Students, to contain Books of Reference, convenience for Drawing, &c., &c.

This establishment may also be made to fulfil another object whose want has long been felt. It may be made to serve as a depository for such pro-

* Practical Surveying was first taught at the Royal Military Academy in 1836.

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fessional notes, memoranda, tables, drawings, &c., &c., as may be procured. Young Officers will then know where to seek information on practical points as they may want it, instead of being, as they now are, at a loss where to look for it.

(5.) Doctor Gregory, Mr. Christie, and the other Professors and Masters of the Royal Military Academy, will be invited to become Honorary Members, and the Officers of the Royal Engineers are also proposed as Honorary Members.

(6.) The Committee will make such purchases as they may think advisable, or obtain Instruments on hire that are found too expensive for the infancy of the funds.

(7.) A statement of the objects proposed will be respectfully laid before the Master-General, and his approval and support solicited. As soon as his support shall be obtained, together with that of the Superior Officers of the Corps, and a sufficient sum raised by subscriptions and donations, the Plan will be immediately carried into execution.

(8.) It is hoped that the Master-General will ultimately find this Establishment of sufficient importance to appoint an Officer to the permanent charge and superintendence of it. In the mean time the Committee will make arrangements for the performance of those Duties.

Possessing as this Regiment has done, and happily still continues to do, the reputation of being a Scientific Corps, such an institution as this cannot be considered out of character. Officers of the Line have long possessed in the Senior Department at Sandhust, advantages nearly equal to what are here proposed; and it is respectfully submitted, that while that Institution has been yearly sending a class of Officers of scientific acquirements, into that branch of the Service, no commensurate advantage has been enjoyed by Officers of this Regiment.

Amidst the increasing diffusion of knowledge, a reputation for science cannot long be maintained that has not some solid foundation. A large number of Officers of the Regiment obtain their first Commission at the early age of 17 or 18: it cannot be said that at that period their professional education is complete. Thus they find themselves without experience and without a guide, thrown on their own resources, and scarcely even made sensible of the great field of knowledge they have yet to traverse, before they can hope for eminence as Officers of Artillery. The rational amusement and the facilities for study afforded by such an Establishment as this, may be expected to tempt many to carry out the studies they are only initiated into at the Royal Military Academy, who would not otherwise do so.

It only remains to add that such an association will not be a new thing in the Regiment. In the year 1771, a "Military Society" was formed at Woolwich, for the encouragement and promotion of Professional Science; that Society continued in existence for some years, and led to many beneficial results—the foundation of the Regimental Library may be named among them; and it numbered among its Members some of the most distinguished Officers in the Corps.

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(No. 2.)

Colonel Cockburn to the Proposers.

Woolwich, February 5th, 1838.

I beg leave to reply to your note, forwarding a plan for the improvement of Officers who wish to take advantage, during their residence at Woolwich, of prosecuting those professional studies so necessary to every young Officer commencing his career either in the Artillery or Engineer Corps, and which, without the means at present of procuring Instruments and other requisites for accomplishing such a plan, cannot be attempted.

I feel flattered by your requesting my opinion, which to the best of my judgment I give you.

I cannot but highly approve the motive that has induced you to draw up a plan, which I am convinced will meet the approbation of your brother Officers. I only fear at first commencing, the plan of a subscription will not be found sufficient to cover so extensive a system as you have laid down.

I should advise that you apply to Sir Joseph Maclean and Sir Alexander Dickson for their sanction, requesting them, if they approve of it, to apply to the Master General and Hon. Board to forward your views by the purchasing of Instruments, and for allowing a Room to be allotted to keep them in, and other Books and Plans, which may be requisite for such an Establishment.

In the first instance I should not say anything regarding an Observatory, as I trust that, and other conveniences will be granted from time to time, as the merits of the plan appear to work well, feeling convinced that the Master-General and Hon. Board will cheerfully do everything in their power to forward a system which must tend to improve a body of officers, whose services to their country must be of the first importance. Regarding a Subscription, I am ready to subscribe any sum that may be found requisite, when you have matured your plans.

I have only to observe that as far as my exertions can be of any service you may command them. You may if you think proper mention to Sir Joseph Maclean and Sir Alexander Dickson, that I cordially approve of the scheme, though I am doubtful, on the score of expense, of the probability of carrying it at first to the extent proposed by you.

I remain, &c.,

JAS. COCKBURN.

(No. 3.)

Colonel Cockburn to Major-General Sir Joseph Maclean,

Woolwich, February 16, 1838.

SIR,

Having had the honor to lay before you the enclosed paper, and as you

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are fully aware of the nature of them, I refrain from making any further remarks upon this subject. The Officers have requested me to lay them before you, hoping for your kind support.

When you mention the subject to the Master-General, soliciting his sanction and patronage, will you have the kindness to say that the Officers would have begged you to have submitted it to him in the first instance, before they took any steps on the subject, had they not apprehended that it was more likely to be satisfactory and respectful to Sir Hussey, having the support of a considerable number of Officers, amongst them Sir Alexander Dickson and yourself, than to have presented it to him at an earlier period, but in a more undigested form, and conceiving that at this present moment the plan in agitation is so far advanced, that the Master-General, through your good offices and valuable support, will be more readily induced to sanction the undertaking with his patronage and protection.

I have, &c.,

(Signed) JOSEPH COCKBURN,

Colonel, Royal Artillery.

Sir Joseph Maclean,
&c., &c.,

(No. 4.)

Commandants Office, Woolwich, 16th February, 1838.

SIR,

I have the honor to transmit to you the enclosed papers, and to request you will be pleased to submit the same for the Master-General's consideration.

I have, &c.,

(Signed) J. J. MACLEAN.

Major-General.

Major-General Sir Alexander Dickson,
Deputy-Adjutant-General,
Royal Artillery.

(No. 5.)

Colonel Sir A. Dickson, Deputy-Adjutant-General to the Secretary to the Master-General.

Deputy-Adjutant-General's Office,
Woolwich, 16th February, 1838.

Sir,

Will you have the goodness to submit to the Master-General the enclosed letter from Sir Joseph Maclean,

The Master-General's Reply.

It appears to me that an establish-

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covering a proposition on the part of a number of Officers of the Corps to promote scientific pursuits at Woolwich, which I think is well deserving of encouragement; though I have doubts, in the first instance at least, whether it could be established to the extent suggested; but, nevertheless, I would propose that Sir Joseph Maclean should be sanctioned to authorize a suitable Committee selected from those concerned, to digest the proposal into such form as the circumstances of the case, and the probable means would warrant, by which the Master-General would be able to judge how far public aid in any shape could be afforded.

I have to add that I never heard of any such society as is stated to have existed in 1771, though perhaps four or five persons might then have carried on in conjunction objects of science; but though nothing of the sort may have been previously pursued, that in no way diminishes the merit of the present scheme, which I am happy to state has emanated from the younger Officers of the Corps. *

I have &c.,

(Signed) A. DICKSON,
Deputy-Adjutant-General.

I have to request that the papers may be returned.

Colonel Fox,
&c., &c., &c.

ment such as that proposed would be highly advantageous; and most especially so to the young Officers of the Corps, from the facility it would afford them of pursuing that course of education in which they had been instructed at the Academy; but in which, from the early age at which they quit that establishment, they cannot expect to have been perfected. I therefore highly approve of the proposal, and I desire that the means suggested in this letter of calling together a Committee for the purpose of bringing the subject before me in a more digested shape may be resorted to under the authority of Major-General Sir Joseph Maclean.

(Signed) H. V.

February 17th, 1838.

* NOTE.—*The "Military Society" in question appears to have fallen to the ground on the breaking out of the American War in* 1775 *or* 1776, *but the writer was told by Major-General Dundas that he thought it survived until the death of Major-General Desaguliers, in* 1780. *The Papers remained in possession of Dr. Hutton, the Secretary; hence it is not surprising that Sir Alexander Dickson, whose first Commission dated from* 1794, *should never have heard of the Society. They were left by Dr. Hutton to Dr. O. Gregory, by whom they were presented to the Institution, and an abstract of them is annexed to this Preface.* J. H. L.

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(No. 6.)

No. 2 of Regimental Orders.

24th February, 1838.

The Master-General having highly approved of the proposition laid before him for the establishment of a society for scientific improvement in the Regiment and ordered that a Committee be appointed under the superintendence of Sir Joseph Maclean to deliberate on the best means of forwarding so desirable an object, the Commandant requests that Officers having any suggestions to propose, will kindly communicate them in writing to the Committee.

Address to Colonel Cockburn, Commandant's Office.

(No. 7.)

Report of the Committee.

Woolwich, May 8th, 1838.

The Committee of the Regimental Institution, appointed by the late Commandant Major-General Sir Joseph Maclean, K.C.H., having reassembled, have the honor to lay before Lieut.-General Lord Bloomfield, K.C.B. and G.C.H., the results of their inquiries, together with recommendations arising from them.

1st. They beg to call his attention to the amount of Subscriptions and Donations already received; and they are sanguine enough to hope for a much larger amount when replies to their circulars shall have been received from the Foreign Commands.

Subscriptions	£208	0	0
Donations,...	169	10	0
	£377	10	0

2nd. They have to mention the sum that will probably be required for the purchase of Books, &c., in addition to those that have been promised or presented to them.

Books,.....	£7	13	6
Stationery, ...	7	12	0
	£15	5	6

3d. The sum that will be requisite in order to supply the Instruments necessary to commence the Researches, Observations, and Experiments, which the Institution is intended to facilitate and perpetuate by adequate records.

Instruments,	£190	6	0

4th. The Committee beg to submit a ground plan and elevation for the building. It will contain the Instruments and Books, &c., is adapted for an Observatory, and it further affords space for the formation of cabinets of Geology and Natural History, and for the reception of specimens of Minerals, &c., &c., such as Officers of the Regiment in their varied service, have great and peculiar advantages in collecting.

Estimated expenses,.....	£409	0	0

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Although the estimates for this building have been made out on the most economical scale; the Committee still fear that it will be a considerable undertaking for the funds of the Institution; and they would beg to point out a measure by which similar advantages might be procured to the Institution at a less expense, viz.: by converting the end of one of the sheds in the Repository into a building for the purpose.

This might be done for about £200.

As however the Superintendent of the Royal Military Repository is of opinion that no part of these can be spared without very serious inconvenience to the public service, the Committee present their plan, with the hope that some assistance may be given by the Honorable Board, to enable them to carry it into execution; this will obviate the inconvenience Colonel Patterson fears from the appropriation of any part of the Repository shed.

A suitable site for an independent building, may be found near the racket court, at the east end; or in the neighbourhood of the Mortar Battery, at the west end of the barracks.

5th. The Committee recommends that one room attached to the building be reserved for a person to reside in, who must have charge of the valuable Instruments, Books, Collections, &c., contained therein.

6th. In order that the different studies and enquiries may be carried on with convenience to the Officers, the Committee venture to hope that the Master-General and Hon. Board will be pleased to give this establishment analogous advantages to the Regimental Library, with respect to fuel, lights, and furniture.

7th. The Committee trust that they do not exceed their instructions when they venture to request that Lord Bloomfield would adequately explain to the Master-General and Hon. Board, the great importance of such an Institution as that now about to be formed, which has hitherto received the support of almost every Officer of the Corps, from the highest to the lowest ranks, and which with the fostering care of those authorities, may be reasonably expected to become a source of great and unseen benefit to the Royal Regiment of Artillery.

The Committee at this period will not take upon themselves to point out how the Institution when formed shall be governed, or what rules and regulations may be necessary for the working out of the plan, regarding it as inexpedient to attempt any thing of the kind, especially as the Master-General as the head of the Corps, will no doubt take such steps in his official situation, as his great military knowledge and experience may suggest.

The Committee cannot close their report without expressing their obligations to Dr. Gregory for his valuable advice and directions with respect to the Instruments proposed to be purchased, to Lieut. Denison, R.E., and Mr. Wilson the Clerk of Works, to whose kindness they are indebted for the Plans, &c., which accompany their Report.

(Signed) JAMES COCKBURN,

Colonel and President.

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(No. 8.)

Letter from Sir Alexander Dickson to the Master-General, forwarding the Report of the Committee.

SIR, Woolwich, May 16th, 1838.

Will you have the goodness to lay before the Master-General the accompanying communication from Lord Bloomfield, forwarding a letter from Colonel Cockburn with enclosures, containing a report and details relative to a scientific establishment, proposed at Woolwich; and in submitting the same, I beg to be permitted to express my conviction, that such an Institution would be of infinite benefit in promoting the science and instruction of the corps of Royal Artillery, and I therefore hope that the Master-General and Board will be induced to approve of the measures submitted, and to afford substantial aid in such a manner as may appear suitable to carry into effect so laudable a measure.

I would further submit, in the event of the Master-General and Board being pleased to sanction the establishment in question, that its management should be regulated under the same control and authority as is observed with regard to the Regimental Library.

(Signed) A. DICKSON.

Colonel Fox, &c., &c., &c.

(No. 9.)

Lord Bloomfield's Report.

Woolwich, June 9th, 1838.

In obedience to the Master-General's commands, contained in his two minutes of the 11th and 18th May, 1838, directing

Lieut.-General Lord Bloomfield, Major-General Sir Joseph Maclean, Lieut.-Col. J. E. Jones, As.-Adjt.-General, to state what preparatory steps should be taken to further the report of the Committee of the Scientific Institution, dated 8th May, 1838.

We have the honor to report,

That we consider it necessary in the first place to secure some apartment to contain the Instruments and Books already obtained by the Committee, and others about to be purchased, there being funds for that purpose.

Seeing therefore the necessity of making a commencement for an Institution so desirable to the advancement of the Corps, in scientific pursuits, at the same time not losing sight of a position where military security can always be afforded without drawing on the Garrison for additional means, we cannot but consider the Royal Military Repository is the fittest place as a temporary measure for the above purposes, and we beg to recommend that either the new room lately finished in No. 2 shed,

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or the two rooms used as school and model rooms for Non-Commissioned* Officers be appropriated for the present for the purposes of the Society, and we submit that it be left optional with Colonel Paterson to decide whether he will continue to occupy the present school-room with its anteroom, or whether he would prefer the long room recently finished.

This arrangement being only temporary, will still leave, for the purposes of the Non-Commissioned Officers instruction, more extended room than has hitherto been allotted them, and will give time to deliberate upon the most fit situation for erecting an Observatory, and other appropriate rooms so soon as the funds now expected from the Foreign Stations shall be ascertained.

By adopting such a plan, the Institution will be able without further delay to make internal rules and regulations, and to commence the selection and choice of Instruments, while its members will be enabled at once to begin the practical studies which it is intended to facilitate and encourage; we therefore strongly recommend this as the measure which may be at once adopted.

We cannot, however, but express a hope, that the site of the proposed building may be *speedily determined upon*;† because, whether the buildings be entirely new, or consist of a modification and enlargement of some that are already existing, considerable time must be occupied about them, which it is exceedingly desirable should be abridged as much as possible, to prevent any dimunition of the strong wish now felt to see the proposed Institution in actual operation, to the promotion of which the Master-General has so liberally contributed.

With respect to the other points in the Master-General's Minutes, we beg to observe, with submission to his judgment, that it will be more advisable for the Officers of the Royal Engineers to be admitted as Honorary Members than as permament subscribers. They will enjoy the substantial benefits of the Institution, and besides aiding it by their experience, may contribute in various ways towards its establishment and enrichment, while the Officers of the Royal Artillery will have the government of their own Institution,—secure its Regimental character, and enjoy the undivided honor of its having originated and been matured by them.

* The Superintendent of the Royal Military Repository proposes for this purpose "the addition made to the model-room, and if that is not enough, a corresponding space taken from the west-end of the long room, running up a brick partition, and converting a window into a door." I shall regret extremely to interfere with the studies of the Non-Commissioned Officers or the duties of the Superintendent of the Royal Military Repository, but as there are but a very small number of Non-Commissioned Officers that can at present be spared for the Repository instruction, and as for very many years past before the new room was erected, the accommodation was (if not exactly sufficient) such as enabled the Superintendent to carry on the duties without any serious inconvenience. I am not prepared to say that the expense of making the partition, &c., should be incurred, but prefer adopting the recommendation of the Officers directed to report upon this subject, and allow the new room in No. 2 shed to be temporarily occupied by the Society, unless the Superintendent should prefer keeping this room and giving up the present school-room and model-room.

(Signed) H. V.

June 13, 1838.

† This will rest with those on whom the management will devolve, but I am clearly of opinion that as soon as possible the site should be determined on and the building erected.

(Signed) H. V.

June 13, 1838.

I can have no difficulty in concurring in the views and opinions expressed in this, and the following paragraphs.

(Signed) H. V.

June 13, 1838.

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That the Officers of the two Corps should be associated together in every thing tending to science, and in all possible situations, we warmly desire, and we conceive that this will be fully effected by the above arrangement.

In conclusion, we beg to suggest, that Colonel Cockburn and Lieut. Lefroy, be requested to undertake the superintendence of the Institution, and conduct the correspondence, &c.; and that they be authorized to procure from among the Pensioners of the Regiment, a proper person to reside on the spot, and have charge of the apartment, together with the Instruments and Books.

(Signed) BLOOMFIELD, Lt.-General.
J. MACLEAN, Major-Gen.
J. E. JONES, Lt.-Col., As.-Ajt.-Gen.

Having in my marginal notes expressed my opinions on this report, I can only again state my great anxiety, for the prosperity of this Institution, and my readiness in every way in my power to assist in contributing to make it prosper, convinced as I am, that it is equally calculated to promote science, and the advantage of the service, and to do honor to the Corps.

(Signed) H. V.

June 13, 1838.

(No. 10.)

Minute by the Master-General forwarded to Colonel Harding, Commanding Engineer, with the Plans for the Royal Artillery Institution, for which he was directed to make Estimates.

Received 9th May, $\frac{M}{170}$

To the Board,

The accompanying Memorandum from Major Sabine, of the Royal Artillery, has been drawn up by my desire*:—the subject to which it has reference is of the utmost importance: the many instances in which Officers of the Ordnance Corps, have within the last few years, been called on to perform duties, for the proper discharge of which, scientific acquirements, somewhat beyond those which they have an opportunity of attaining by the education at Woolwich Academy, are necessary; and for their knowledge of which, they have been indebted to their labours and studies after quitting it; and in the execution of which duties, they have obtained for themselves and their Corps, a very great degree of credit; and the circumstance, most especially of these Officers of the Artillery, having within the last few days been appointed to carry out some scientific experiments on Foreign Stations, altogether, lead me to believe that the Institution, lately formed under the superintendence of a Committee of Officers of the Royal Artillery (the formation of which reflects so much credit on the Corps, and the expenses of which have hitherto been defrayed by private and voluntary subscription), might be rendered particularly useful in giving further instruction to such Cadets at the Academy as might be desirous of obtaining it, or as might be selected by the Professors, as especially qualified to be instructed in branches of science not immediately coming under the regulations, by which the present system of education is governed.

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* There is no copy of the paper referred to in the Records of the Institution.

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This memorandum of Major Sabine has fully confirmed my anticipations, and I therefore desire that the Board will in reference to a document in which the manner is explained, whereby aid might be afforded to the Institution lately formed (and which document I placed some days since in the hands of the Clerk of the Ordnance), take measures for assisting in raising the proposed buildings, the expenses being charged to the Academy.

In the communication with the Lieut.-Governor of the Academy, I shall make such arrangements as may appear necessary to enable the Cadets to take advantage of the opportunity that will be afforded to them, of acquiring through the establishment of this Institution, the additional information and instruction, so desirable in every point of view, both as regards themselves, and as regards the services they will thereby be enabled to render to science and to their country.

(Signed) H. V.

May 6, 1839.

The site for the Building finally decided upon was the ground above the gravel pit outside the enclosure of the Repository. It was well suited for the Observatory, and for practice with instruments, and not considered too far from the Barracks for the other objects of the Institution. The plan and estimates having been approved of by the Board of Ordnance, the building was commenced in September, 1839, and completed in September, 1840. It was executed by Sapper labour, at an entire cost of £725, of which £200 was paid out of the funds of the Institution, and the remainder by Government.

The Institution being now fairly started, required time only for its development. Its growth was chequered by the intervals of retardation, which invariably accompany all enterprises of the kind. One cause, which for a brief term checked its activity, eventually turned to its great advantage. The illustrious Humboldt had shortly before this time brought to the notice of the Royal Society the state of the science of magnetism, and pointed out the incalculable importance of a combined plan of simultaneous observation over the entire globe. He urged the facilities which England enjoyed for loudly promoting this noble enterprise, from her wide spread possessions, some of them situated in the regions of greatest magnetical importance. His proposition was heartily received by the Royal Society, and pressed with all its influence on the Government. The result was the equipment of a Naval Expedition to obtain observations in the Southern Hemisphere, and the establishment of the Colonial Magnetical and Meteorological observations. These observations, under the general superintendence of Major (now Major-General) Sabine, were directed by Officers of Artillery, assisted by picked Non-Commissioned Officers of the corps. The Officers selected for the charge of the observations were among those most actively interested in the Institution, and their sudden removal abroad reduced the number of its more ardent supporters. But though absent from the Institution, they did not cease to rejoice at its progress, and when, the objects of their mission being fulfilled, they returned to England, they brought back with them a deeper conviction of the necessity of its establishment, and increased experience for its management.

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Many circumstances combined to hinder the efficient working of the Institution, and to prevent its being so useful to the Corps as it might have been.

Great efforts were quietly made about this time to interest Officers of the Corps in its further development, and by unremitting exertions, the general feeling was aroused in favour of extension. This movement resulted in a very general feeling in favour of many improvements, as regards the Library, Reading Room, and Mess Room, to which it is not now necessary to allude.

In June, 1849, more general attention was directed to the subject by the turn taken in an enquiry before a Committee of the House of Commons in examining one of the witnesses.*

At a Meeting of the Royal Artillery Institution, held on the 9th November, 1849, it was resolved—

"That as the endeavours of the Committee to carry out some plan for placing the Royal Artillery Institution on a broader basis, have caused a

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* The following is the Examination referred to:—

GENERAL PARKER, C.B., EXAMINED.

Mr MILLS.—After a cadet gets his commission in the artillery, will you be kind enough to state to the Committee what time he remains in Woolwich?—That depends upon the exigencies of the service, and the Adjutant-General's roster.

Are any general means of instruction, supposing an officer having left the academy should wish to perfect himself in a scientific branch, afforded him?—He has the capability and the option of attending certain oral lectures in chemistry, astronomy, mechanics, mineralogy, and meteorology, besides his military duties at Woolwich.

Do you conceive that sufficient means of instruction to an officer who wishes to perfect himself in his duties are afforded by what you have stated?—I do.

Have the officers of the corps adopted any system themselves of gaining more instruction than the Government have afforded them?—Not that I am aware of; there have been several schemes proposed, but nothing has been carried out. I believe there is now, thanks to Captain Wilmot, something going on in reference to a scientific institution connected with the Ordnance, but it must incur a large outlay, and therefore there is very great difficulty in carrying it out.

The officers conceive there is a necessity for it, and they are endeavouring to carry it out themselves?—Yes, by their private subscriptions.

CAPTAIN EARDLEY-WILMOT, R.A., EXAMINED.

Mr MILLS.—Will you mention what the nature of that institution is?—It is an entirely voluntary association among the officers themselves; the original intention was by small subscriptions, that they should be able to purchase such astronomical and other instruments as are too expensive for the generality of the officers of our corps to purchase; that they might by the use of those attain all the necessary qualifications to be travellers, and surveyors, and so on. When I was a cadet myself there were none of those lectures in astronomy or surveying generally which are now given, and are intended to be given in future, therefore we have felt very much our own deficiencies. We have endeavoured also by beginning this in a private way to draw the attention of the Ordnance towards the deficiency of our instruction in regard to our own artillery duties. We hope to make the institution eventually the means of communicating with the whole of our regiment as to all the practice and experiments carried on at Woolwich.

How long has the attempt to get up that institution prevailed with the regiment?—I think about twelve years.

And notwithstanding the wish of the officers thus to improve themselves, the Ordnance have not come forward in any way to assist them?—The Ordnance gave us the ground upon which our building is erected when it was built in 1838.

There is a building now, is there?—There is a small building, but totally inadequate to all the purposes which are required. The institution has not effected the purpose we have principally in view, which is the carrying on our own professional education.

Have you made an estimate of what the cost would be, of building a sufficient institution?—We have made several estimates, and devised various plans, some of which have been submitted to the Ordnance.

To erect an adequate building for the purposes you have mentioned, what would be the cost?—Supposing the institution stood alone disconnected from the reading-room, the libraries and the mess, it would cost about £4000.

Connected with them, what would it be?—It is difficult to say what it would cost; the last

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strong feeling in favour of other improvements also, which have, after nearly two years, resulted in the arrangements now in contemplation for removing the Library from its present site to the proximity of the Mess Room, and as in the contemplated arrangement, the Institution, as such, has no place; the Committee is of opinion that the general feeling of the Regiment makes it desirable that something effective be now undertaken."

At a Meeting of the Committee, held on the 21st November, 1849, it was resolved—

"That the number of Names, and the amount of Subscriptions, are satisfactory indications of success."

It was therefore resolved,—

"That measures be adopted for making the proposal more public, by obtaining permission for the List to be placed on the Reading Room table at Woolwich, by forwarding the same to the several Stations at home and abroad, and to Officers retired from the Regiment."

Resolved also,—

"In requesting Officers to subscribe their names and money towards the objects of the Royal Artillery Institution, it is advisable that a short outline of the principal features of the proposed arrangements be submitted to them at the same time."

In furtherance of which resolution the Committee beg to state, that they have reason to hope that a convenient and appropriate site will be afforded them by the Master-General and Board; and as they consider that there are certain apartments indispensable to the great object of furnishing to every

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estimate that was made for it, there appearing to be a strong feeling that it should be done, was nearly £12,000, which we proposed to raise among ourselves.

How much has been raised by subscription among the corps towards either purpose?—The funds of the institution consist now of about £700, collected in very small sums; a lieutenant pays half a crown a year towards it; we have patiently waited all these years in the hope of obtaining sufficient money to do our own work without any assistance.

Supposing an observatory to be attached to your reading-room, what would be the cost of the instruments?—We have sufficient instruments for all common astronomical purposes; what we principally want is a lecture-room and rooms for meeting in. As I said before, our final object is not so much to learn astronomy as it is to have a central point from which information of what goes on at head quarters, and the scientific improvements in our own profession, should be circulated throughout the corps, all of which now is completely swamped at Woolwich, and lost to every one unless he happens to know what is going on by going down to see it.

Mr F. MAULE.—Could you circulate that information to which you allude throughout your corps without the danger of making it more public than would probably be right and proper in such a corps as yours?—There is no hindrance to its publicity now; no one is excluded from witnessing experiments if he happens to know they are going on.

The public are not permitted to be present at experiments of a delicate nature, are they?—It is not sufficiently known to attract anybody; I never heard of any one being excluded.

Is there any professional library at Woolwich?—There is a library belonging to the regiment of artillery.

That is the regimental library?—Yes.

Does that consist of professional works, by which an officer can advance his profession, as well as gain amusement?—There are a considerable number, and of course that number can be increased to any amount, as the regulation of it is in the hands of the officers themselves; what we want now is room; the books are in some places four deep.

With regard to the library itself, do you think it is at present in a sufficient state, as a professional library, to meet the wants of the corps?—As a military library I should think it is first-rate.

Mr GREEN.—Are there any buildings at Woolwich which, by arrangement, could be given up for the purpose?—There is a plan in the hands of Lord Anglesea at this moment, I believe, to convert a portion of the barracks into a reading-room and library, adjacent to the mess-room. In this plan the institution is completely rejected altogether. It does not contemplate instruction.

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Officer entering the Garrison, suitable means of obtaining instruction and information; of making generally known the progress and application of science, and for carrying on continuous intercourse with their brother Officers, whether in the service or retired, in all parts of the world; they, therefore, suggest a few words relative to each.

Lecture Room.—This is one of the most important features of the proposed arrangement. The Committee desire to have regular courses of Lectures, by competent men, on such subjects as Chemistry, Geology, Metallurgy, History, and Military Law, &c., &c., besides occasional Lectures on Veterinary Science, or any other subject likely to be generally useful and desirable. They hope to find among the Officers themselves some who would occasionally add to the general fund of instruction, by Lectures on such subjects as Strategy, Military Machines, the peculiarities of any great battles, with the service of Artillery in our Colonies, or on the occasion of its being used by other nations. New applications of the Arts and Sciences, and any thing connected with the general progress of knowledge, would be very desirable as subjects for Lectures.

Laboratory.—This very important part of the plan provides the means of occupation and interest for any number of Officers. Several are already engaged in such pursuits. The connection of Chemistry and Medical Science will, without doubt, insure the support of the Officers of the Ordnance Medical Department, some of whom, it may be hoped, will not be unwilling to disseminate the knowledge of Chemistry and Natural Science.

Even if that plan were carried out it would be very beneficial to the corps?—It would.

It has been stated by General Parker that there is at present the means for officers obtaining oral lectures and instructions; do you agree that that is the case?—There is every facility for their doing so, except the want of accommodation and time to do it in; there are capital men to instruct them, and everything in that way that is required except a central meeting point where it can be done; but these are not strictly professional subjects of artillery instruction, which is what we want.

Mr F. MAULE.—Suppose you had all the advantages at Woolwich, is it your opinion that the great body of the young officers who are just entering on the service of the artillery and engineers would avail themselves of the opportunity of studying?—I think a great many would do so voluntarily, and I think they all should whether they liked it or not.

You think there should be some system of compulsion?—I think an engineer officer is not considered to have his education complete till you send him to Chatham, and I do not see why young artillery officers should not be for 12 months after leaving Woolwich instructed further in their artillery duties; no one can say that the instruction at Woolwich can be anything but elementary; it is true the officer goes through a practical course for a twelvemonth, but it would be much better that he should for a twelvemonth more carry on all those things which he had only begun when he was at the academy.

Mr MILLS.—Is it felt as a grievance that the engineers have the power of forwarding themselves more than artillery officers have?—I do not think it is felt as a grievance while the man is second lieutenant, but he feels the effect of it afterwards, and is sorry for it.

Colonel ANSON.—You are aware that there has been great difficulty in finding a locality for this institution?—We can point out one very easily.

Are not you aware that there has been some difference of opinion among the officers of the regiment as to the proper situation in which it should be placed?—There is a difference of opinion upon this point mainly:—the question between them is, whether the whole three, the reading-room, the mess, and the institution, should be joined in one, or whether the reading-room and mess should be kept together and the institution be separate from them. There is no difference of opinion as to the necessity of, and continual striving for, professional improvement.

You are aware that the present Master-General of the Ordnance has been most anxious to forward the views of the officers?—Most anxious.

And that it is at this moment under consideration, a plan having been called for, or suggestions, as to the establishment of it?—I am aware of that; but it is for a library, and does not meet the question of professional qualification.

Second Report, July 12, 1849, p. 449, Questions 6932—6961 inclusive.

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Observatory.—As it is not proposed, and there would be no advantage, in making the Observatory anything beyond a means of instruction in the use of instruments, little accomodation will suffice for this purpose. Any one undertaking a journey with scientific objects in view, either on his own account, or for the Government, might find himself in many positions, where a knowledge of the use of the more ordinary astronomical instruments would be of great value.

Museum.—This should be a large room, to contain models, drawings, and constructions of any equipment, either in our own service, or that of other nations; works of art, modern and antique; specimens of Natural History, with collections of Minerals, Geology, &c., which would also be useful in the elucidation of Lectures. With Stations in so many parts of the world, and with the strong national taste for field sports, many valuable specimens of birds, animals, &c., might be expected so soon as Officers felt that the proceeds of their skill would be preserved and exhibited. Instruction could be giving as to making collections, and in the art of Taxidermy and Dissection, to any Officers desiring to enter this branch of knowledge.

Drawing and Book Room.—This is essential, as furnishing the means of ready reference to the books of the Institution, connected with the Lectures, &c. Conveniences for drawing, copying plans or models, as well as for making extracts and notes, would be most desirable.

Apparatus Room.—This is to be situated close to the Lecture Room, as a place of deposit for any article required in the Lectures, and as a room in which the Lecturer might prepare what he required for his work.

The remaining apartments would comprise a room for the meeting of the Committee, and a Secretary's Office; a room for the Printing Press of the Institution, and Quarters for the Serjeant in charge.

In consequence of the representations made to the Marquis of Anglesea, Master-General of Ordnance, of the importance of extending the Institution, and of carrying the above proposals into effect, he was pleased to recommend the erection of an enlarged building, at the public expense.

This was agreed to by the Lords' Commissioners of the Treasury, and the liberal provision of £5,350, for the erection of the present building, was made in the Ordnance estimates for 1851-52, of which sum, £2,684 was expended in 1851-52, and £2,666 in 1852-53.

The Committee of the Institution, on their part, made every exertion to ensure the immediate prosperity and usefulness of the Institution under its new auspices.

During 1853-54, they expended £942 11*s.* 10*d.* on the necessary furniture and fittings, in stocking the Laboratory, and in the purchase of instruments.

The building was opened on the 1st of February, 1854, and the inaugural address delivered by General Sabine, than whom no officer could be better fitted, by his eminent place in the scientific world, to urge the claims, which science, as the guide or auxiliary to practical knowledge, must ever have upon the attention of a body of military men whose service is so diversified, and whose early education is of such a character, as that of the Officers of the Royal Artillery.

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Abstract of Papers respecting the Military Society, Established at Woolwich, 1772-3-4-5.

(No. 1.)

Captain Alex. Jardine, R.A., to Captain Edward Williams. R.A.

June 20th, 1772.

Dear Williams,

I have been thinking there must be a good deal of knowledge scattered about in this numerous corps—could it not be collected, concentrated, (so to speak) and turned to some effect? We have already in this country all kinds of Societies except a military one. I think a voluntary assocation might be formed amongst us, (admitting perhaps Engineers and others) on liberal principles, viz., for improvement and amusement, where military, mathematical, and philosophical information being the chief objects of our enquiries, essays, &c., knowledge might thus be improved and propagated. The Society might thus communicate and increase their own ideas, preserve themselves from vulgar errors, and keeping one another in countenance, bear up against the contempt of pert and presumptive ignorance. If it increased in numbers and grew into consequence they might in time bring study and real knowledge in fashion, and retorting a juster contempt, keep mediocrity, and false or no merit down to their proper sphere."

He goes on to explain his ideas and states the qualifications to be required of members of the Society, viz.:—

"An acquaintance to a fixed degree, with Geometry, Algebra, Mechanics, Fortification, Natural Philosophy, History, Law, and Politics, otherwise admittance would be of little service to themselves or the cause. To show

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the liberal nature of the thing, it should likewise be made known that if any young man has a mind to qualify himself, and be admitted, he may accomplish it by force of application, with the assistance of some well chosen friend, and the perusal of certain authors whom the Society would recommend, among whom I should beg to place—

Ancients.	Of the Moderns.		
	Mathematical and Philosophy.	Military.	History, Politics, &c.
Euclid.	Emerson.	Puisegar.	Robinson.
Herodotus.	M'Laurin.	Folard.	Hume.
Thucydides.	Newton.	Saxe.	Macauley.
Xenophon.	Robins.	Monticueuli.	Blackstone.
Arian.	Gravesand.	Turenne.	Locke.
Vegetius.	Desaguliers.	Fouguier.	Bolingbroke.
Polybius.	Coates.	Lloyd.	De Thou.
Cæsar.	Ferguson.	Coehorn.	Davila.
Livy.	Nolet.	Vauban.	Sully.
Sallust.	Simpson.	Trincano.	P. Daniel.
	Belidor.	Muller.	Du Retz.
	Mauduit.	Du Pain.	Montesquieu.
		Du Lacq.	Helvetius.
			A Ferguson.
			Grotius.

"The proceedings would chiefly consist of members reading their essays, proposals, &c., and those communicated from members abroad; afterward in speaking to each, those to be booked or recorded by the Secretary according to their degree of merit which should be decided by a majority present. By those means many thoughts, hints, and even inventions of sensible and ingenious men would be preserved from oblivion and communicated. In short, I can conceive it productive of a number of valuable consequences, &c. Suppose it to consist at commencement as per margin, others will doubtless, on inquiry, be found who are sufficiently qualified.

But here in danger of habitual stupidity, or contagious nonsense, I trust not my own thoughts, and therefore thus communicate them to thee, who wilt judge fairly and impartially between them and me, &c.

Gen. Conway.
Capt. Williams.
" Congreve.
" Foy.
" Blomefield
" Shand.
" Jardine.
Lieut. Dorset.
&c., &c.
Mr. Brown, Woolwich.

Remember that however foolish at times I am a real friend to thee and genius.

A. J.

P.S.—I have been examining the list of the Regiment and fear there are

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not yet many more so highly qualified and disposed for such a thing as could be wished, unless it be among the young ones who I do not yet know, or among the Field Officers whose protection and assistance would be necessary, if a commencement or meeting of a few could once be obtained where that and other things might be determined. Voluntary societies of this kind are perhaps capable of greater exertions than any establishment by government, in these the subjects proposed should be treated with that unrestrained and easy freedom which is incompatible with any degree of military subordination, so that it would perhaps be best to begin privately amongst a few young men nearly equal in those respects.

Argo Transport,
June 30, 1772.

Captain Williams to Captain Jardine.

Sibilla Transport, Stangate Creek,
1st July, 1772.

DEAR SIR,

The Corps of Artillery have been so long established, enlarged, and improved, that it becomes natural to suppose there may be much useful knowledge dispersed amongst them. Most of the junior Officers, and many of the senior, have enjoyed the advantages of attending the Royal Academy, where it may be presumed they acquired such a taste for military science, as would enable them to make many useful applications of the experience they gained in the two late wars. The gentlemen you have mentioned are amongst the number of those I should have pointed out myself on a similar occasion, and I doubt not there are many others whose talents only require the establishment of such a society to call them forth to action. In order to give it a beginning, suppose the scheme should be communicated to as many of the gentlemen you have mentioned as can be assembled on our arrival at Woolwich, and any others, yet unknown, we may then meet with? The first meeting should not be too numerous, and I think it would be proper to confine it at present either to Officers about our own standing, or Juniors, till such time as we try our strength on some proper subjects. In case of success, we may with more confidence expect the patronage and protection of our superiors, amongst whom the first-rate abilities of the President you have named would do honor to any Society, and I wish this embryo scheme may ever arrive at a degree of consequence worthy of such a patron. Generals Williamson and Desaguliers, and Colonels Pattison and Phillips, are I presume, competent judges of the merits of such a society, and would no doubt encourage and countenance it as soon as it acquired a proper existence. The qualifications necessary for admittance, will be most properly determined at our first meeting, and will probably coincide in most points with those you have sketched out; but we must rather be moderate in our expectations at first setting out. Time and a laudable emulation will

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produce many ideas and improvements which lie concealed in every mind on a transient inspection. Your list of authors is, I think, well chosen, and perhaps it might in time be found practicable for the Society to establish a small select Library at the Head-Quarters for the use of the members. The Library-Room would be the properest place for Meetings, Debates, or Study, as immediate recourse could be had to any author that might be quoted or wanted on such occasions. But I forget that this Society is not yet in being, and shall therefore postpone any farther sentiments till the castle in the air gets footing on terra firma. In the meantime to shew you how earnestly I wish to see it go forward, I send you a specimen of the easiest way in which the modern art of Gunnery might be taught, which (with some other subjects essentially necessary) I was always astonished to find were not included in the plan of education pursued at the Royal Academy. I am informed that the founder who has succeeded *Schalch* at Woolwich, is particularly well qualified for that Department, his guns and mortars being bored with such accuracy that little more can be hoped for in that way. When we are furnished with such perfect instruments, it will depend on ourselves to use them properly, and I could wish to see a *complete* course of projectile experiments performed with more *accuracy* and *design* than has hitherto been done. You know the curve described by a military projectile is one of the great desiderata (I had almost said opprobria) in the art of Gunnery. If mathematics could have determined it for us, this age has enough of that; but the profoundest speculations on this subject, by deducing it a priori, from any hypothesis of the air's resistance, are not applicable to practice, nor ever can be, whilst the law of that resistance is itself unknown. We must set to work mechanically, and I think I have pointed out one method, and in our own way too, of determining the projectile curve, which will at the same time furnish a useful set of experiments for Artillerists, though of a kind not hitherto pursued. You will find this in the specimen I have sent you, which if you think worthy of being tagged to the observation you shewed me at Gibraltar on this subject, you will take more notice of it than it deserves. I have many things in my head, but our band (consisting of geese screaming, ducks qua-acking, hogs grunting, dogs (and bitches) growling, puppies barking, brats squalling, and all hands bawling) are now performing a full piece; so that whatever my pericranium labours with, it must lie concealed till I arrive at *Retirement's* lying-in Hospital in *Solitude* Row, where I shall hope for a happy delivery.

Excuse this scrawl from one who is

always yours,

E. WILLIAMS.

P.S.—As to your postscript it could never be supposed that because a set of *military* gentlemen form themselves into a society for the mutual communication and promoting of knowledge, that there must ensue a subordination of ideas. I wish knowledge was always found according to the dates of Commissions, but as that will probably never be the case, let us glean it up even from the ranks, if we can find it growing there.

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(No. 3.)

Letter from Lieutenant Michael Dorset.

Woolwich, 10th July, 1772.

"The scheme proposed by Mr. Jardine is of a nature of itself of most laudable, and greatly beneficial to society; at the same time that the *utile dulci* in its composition must be an eternal source of pleasure, and mutual improvement to its members. But it is to be lamented that the dissipation, or rather the undeviating ignorance of the military world in general seems to involve it in difficulties hardly to be surmounted.

But I conceive a society of this sort would be difficult to form, so as to prevent its degenerating into that insipid thing called a Club; the consequence of which would be, that instead of attending to subjects really interesting, the conversation would become small-talk, &c."

He proceeds to recommend the writing of Essays, &c., and to avoid viva voce disputations; to publish from time to time an epitome of the proceedings, and to elect a president each meeting who should propose the subject to be prepared by next meeting.

(No. 4.)

(From Captain Shand.)

Greenwich, 26th August, 1772.

DEAR SIR,

I am very much charmed with your proposals for a literary society, and still more, to find that there are not wanting a few that show themselves willing to support and encourage so laudable an undertaking. A regular establishment has very much the appearance of being impracticable at present, and must be the work of time.

Approves the appointment of Mr. Brown, as Secretary; recommends those who have essays prepared to send them to him, &c., &c.

(Signed) ALEXANDER SHAND.

(No. 5.)

Proposes Annual subscriptions for library, &c., to be one day's pay. Donations of books, maps, globes, models, &c., to be received. As soon as proposals meet with proper encouragement, to make application to Board of Ordnance for the use of Prince Rupert's Tower to deposit the library in; necessary regulations to be laid before the subscribers for amendment or approbation, as soon as a sufficient number appear, to carry the design into execution.

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(No. 6.)

Offers proposed rules and regulations.

(No. 7.)

Rules and Regulations for the Military Society Established at Woolwich, October 3rd 1772.

1. That the Society shall meet every Saturday preceding the full moon, at six o'clock in the evening, at the military library.

2. That in case a president shall hereafter be judged necessary for this society, such shall be determined at the first quarterly meeting; but that in the mean time the transactions shall be carried on by two secretaries and a treasurer, to whom all letters shall be addressed post free.

An assistant-member shall also be appointed by the majority, in order to preside at each meeting, when it may be found necessary.

3. That the principal study of this society shall relate to such subjects as are either strictly military or evidently connected therewith, viz :—

The sublimer parts of military mathematics especially such as have been either superficially or not at all treated of by others; amongst which may be comprehended the projectile curve, the law of inflammation and force of powder, the velocities of shots and shells, construction of pieces of artillery, arts of fortification and mining, all kinds of naval improvements, &c., &c., &c.

4. That the particular business of the monthly meeting shall be to read the correspondence of the members, and discourse thereon; propose new subjects; read, and make remarks on any military publications, and to record and preserve such proceedings.

5. That the transactions of the society shall be preserved with inviolable secrecy, in order that each member may freely communicate his discoveries and improvements in any branch of military art, or whatever he may be possessed of conducing thereto, and in case of publication, his consent shall be previously obtained.

6. That whenever the society shall determine upon any course of experiments they may judge necessary for the further advancement of the art of gunnery, mining, &c., &c., application shall be made to the Hon. Board of Ordnance to assist them with the necessary artillery, powder, &c., and such experiments shall be carried on under the inspection of (at least) two members, who shall make a faithful report of the same to the society.

7. That every candidate shall be first proposed by a member, who shall present the society either with some original production of his, or remarks on any of the subjects which may then be under consideration by the society, and upon this test his admission shall depend.

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(No. 8.)

Lieutenant Dorset to Captain Jardine.

Walberton, December 27th, 1772.

It should be premised that this is only meant to offer a few hints, and by no means attempt any regular plan: as I have but just heard of the resolution, which required the opinions of the members concerning the rules for their future regulation, and being as yet entirely ignorant of the proceedings and system hitherto adopted by the society, am obliged to confine myself to a few general principles.

Recommends president in rotation, to avoid viva voce disputations; papers to be registered according to the vote of the majority; a protest to be admitted against the enrollment of anything, which was then to stand over for three months; honorary members to be few; members to be ballotted for; proper books to be provided for registries.

(No. 9.)

A circular letter sent to members on their admission, by the Secretary, Capt. G. Smith,* I.M.S. A copy was sent to Hon. Charles Greville, Lieut. Logan Henderson, Major Lockhart Russel, Captains Benjamin Stehelin, William Congreve, and Thomas Davis.

(No. 11.)

Captain, afterwards Sir William Congreve, declined being a member, on the plea of want of time to attend properly to the duties of one, expressing his sense of the honor, &c. February 5th, 1774.

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* Captain G. Smith, was Inspector of the Royal Military Academy.

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(No. 16.)

Hugh Brown, (Translator of Euler's Gunnery), declined being a member, on plea of time being fully occupied by official duties at the Tower, dated 16th March, 1774.

(No. 17.)

From Dr. Hutton, with a present of Books for the Society.

Sir,

I am highly sensible of the great honor done me by the gentlemen of the military society in constituting me one of their original members. The favorable opinion they are pleased to express of my mathematical performances, by deeming them worthy of a place in their library. I must consider rather as an instance of their politeness than of my merit. I hope soon to have the pleasure of paying my respects to them in person, and in particular to you Sir, for the very polite manner in which you have conveyed to me the sentiments of the Military Society; and when I am better acquainted with their plan and design, I shall think myself happy in contributing any thing in my power towards forwarding so useful an institution, and am with the greatest respect, &c., &c.,

CHARLES HUTTON.

Newcastle, April 14, 1773.

To Captain Smith,
&c., &c.

(No. 18.)

Woolwich, 30th May, 1774.

Letter from Dr. Hutton as Secretary to Lord Townshend, Master-General of the Ordnance,

Applying on the part of the Society for barrels of powder of all the different sorts in store, for experiments on the cause of inequality, &c., &c., in the effects of gunpowder.

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(No. 19.)

Captain Blomefield to Dr. Hutton, containing Lord Townshend's approval of their intention.

DEAR SIR,

I have laid the Society's letter before Lord Townshend, and have the pleasure of acquainting you that his Lordship very much approves their intention of prosecuting the course of experiments on powder.

Had given directions to Sir Jeffery Amherst to supply the powder, but as there were nearly thirty different sorts, Sir J. said a barrel of each would be too much; recommends them to reduce their demands to as small a compass as possible, &c.

"I saw Mr. Irving this morning, who is desirous of trying his cylindrical shot on Saturday, &c. The three points he seems to have in view are their direction, ranges, and penetrations, compared with round shot of the same calibre."

I am, dear Sir,
Your most obedient Servant,
(Signed) THOS. BLOMEFIELD.

London, 14th June, 1774.

(No. 20.)

Letter from Dr. Hutton to Sir Jeffrey Amherst, reducing the request to 20 *lbs. of each nature; requesting* 2 *Eprouvettes, date* 4*th July,* 1774.

The powder was supplied from Purfleet, 6th August, 1774. 9 samples of serviceable, 6 of inferior quantity.

(No. 24.)

A Letter from Dr. Hutton requesting permission to have a small Ballistic Pendulum erected, to fire balls of 1 lb. into, to contain 6 or 8 cubic feet of timber. Dated September 19th, 1774.

There is no list of the first members of the society, or of the precise date of their commencing proceedings.

The first paper is an able tract on Artillery entitled

Some Experiments and observations in Gunnery by Lieutenant Jardine, Royal Artillery—Gibraltar, 1771.

There are four numbers of this tract, amounting to 103 pages.

To Colonel Phillips, Royal Artillery.

Captain E. Williams, on perusing these sheets, having joined his superior abilities towards the improvement of this art, and produced a very ingenious performance, I thought it proper to subjoin it to these, as it renders this a

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book much more worthy thy perusal, flatters me with having been the means of its being produced, and furnishes fresh reasons in support of my favourite position, of which I wish to convince some others, viz.:—

The great and yet unknown effects of a proper junction of endeavours of theory and practice, of similar and even of different kinds of genius and application, when liberally encouraged and assisted in making proper experiments and supported in a constant exertion. Sensible that all which is here proposed cannot be done at once, in order to begin, we have formed a small society, of which this book may be considered as the first production, and where it is proposed to register, and preserve, whatever shall be done or collected with a view to improvement by its members, for the good of this country in particular.

I am, Sir,

Your most obedient Servant,

(Signed) A. JARDINE.

The first two numbers are chiefly filled with tables of practice and practical remarks; they are curious, as shewing the state of Artillery practice at that period, besides being very extensive and complete in themselves.

He laments the inconclusiveness and contradictions of the data, from the want of sufficiently extensive experiments, and the want of encouragement to those who would improve the service.

"The effects of powder have generally been found so irregular that any fixed rule concerning it has hitherto been considered by practitioners as almost impossible; and yet we practice entirely by differences of powder, and never by that of elevation, though more certain in many cases; nor have we yet attempted any courses of experiments sufficient to determine this point. The yearly practice of the regiment, from which the most decisive experiments might be expected as well as the most useful tables, is generally carried on so as not to answer this, and indeed, but very few of the many purposes to which the burning of so much powder might be made to serve. These are strange solecisms in practice, but perhaps more the fault of the establishment than of the gentlemen of the corps. The wisdom of this corps has been such that very little, if any, of the improvement of their own art has been left or recommended to the corps."

He complains that "the mechanical parts of the business such as founding, powder-making, &c.," are not yet sufficiently established upon principles, nor well enough executed; nor is it easy to conceive how they ever can be improved till under the direction of Officers. Of all the 16 5½-inch mortars here, there are not above two or three of the same diameter, and the 8-inch still worse.

"We are indolently inclined to take many things for granted, and to repeat vulgar errors from each other for centuries, rather than take the trouble to try by experiment if things are as reported. I have repeatedly heard all our irregularities of experiment in powder, &c., positively ascribed to different and opposite causes. There seems to be a necessity for that excessive slow-

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ness which we perceive in the progress of the arts. They are probably not to be hurried by great or sudden innovations, yet the velocity (so to speak) of their progress is not necessarily always the same."

"There are several points belonging to, and connected with gunnery that have been waiting for some time, only as it were, to be finished; these deserve our attention as principal parts of our profession, and as chief causes of irregularity or uncertainty in it. Our object is now to assign the proper causes to observed effects, then if possible to measure them."

He enumerates as points which not yet been thoroughly and practically investigated: windage, chambers, shells, resistance of the air, length of pieces. Such researches require the experience of many more years than we are yet aware of, it is therefore not only wrong to discontinue, and as it were to discourage them, but it is negligent or worse not to have some constant establishment on purpose to promote them.

He proposes that proper persons should be appointed who should be furnished with standard pieces of all the different ordnance, and should by careful and long repeated experimen ts at the yearly regimental practice, and on every other occasion endeavour to find out the rules observed in those pieces, &c.,

"There have been few attempts to improve the metal of ordnance, since they first began to be made of metal; nay, the brass seems to be growing worse of late. We have pieces of 200 years old of better metal than that now used. Cast iron is as yet too friable or brittle and apt to fly; the brass too soft and apt to melt too easily. Some iron guns were shewn to me in Spain that had opened considerably without flying. I am sorry to see other nations before us in founding, and in several other mechanical parts of Artillery; and this being almost the only branch wherein any other nation even equals us, it is a strong indication that these things are not in a proper channel, otherwise they must have kept pace with the other arts."

"It is somewhat strange in this scientific age that all our practice and theory has hitherto led to so little positive knowledge in this branch, however, a more general acquaintance with the present state of things than is usually found among us, is necessary to their improvement, and to every young Artillerist; but it is a kind of knowledge which he cannot easily acquire either from books, or the generality of masters, nor even from academies as they now stand, for whatever his progress there may be, if some method is not devised of uniting more experience with his theory; errors or a sort of knowledge very little better than ignorance, will still continue to be the result, together with a lasting disgust to every kind of application; let him learn to give only a proper degree of faith to books, and men of mere speculations, yet preserve a proper respect for their use: his own experience alone can inform him of the present state of things; and if he has a mind to improve any of them he must have recourse to the same method; but he will not be able to make sufficient use of experiment, if he is not acquainted with the mathematical methods of reasoning, with the manner and success of former researches, with the principal theories and opinions, and merits of each; so that by always recommending and referring to experiment, I mean

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not to discard the use of mathematical or philosophical principles from any branch of practice; on the contrary they should be inculcated much more than has hitherto been the fashion. . . . All speculative progress of any use, is founded on truths resulting from experience already in the mind, and the more we extend that foundation, the more may be built thereon. Reasonings or conclusions from facts already known are in this age soon exhausted, so that in order to advance more facts are wanted."

"So many paths still remaining open ought to animate rather than discourage us in our applications, but till those who are concerned and who have any influence, assist in bringing such application into use, little can be expected from individuals who have neither encouragement, sufficient funds, or opportunities."

Complaining that even Robins and Muller were not properly encouraged, and acknowledging the value of what they have done, he goes on . . . "However it either is or ought to be our business to take up the art where others have left it . . . and endeavour to teach ourselves, by catching the few opportuities that offer and try to gather from our small practice something like principles or rules to work by. Though in this enlightened age there are few secrets in any art, yet there appears among us some remains of the old selfish spirit of mystery. It is somewhat surprising that the only two branches of knowledge, by far the most necessary to an Artillerist are yet scarcely, if at all, taught in the Corps. (Mechanics and Gunnery.) These should be recommended and rendered easy, by every familiar method, as well as investigated by those that are purely geometrical, but any considerable progress in this latter method will always be confined to a few geniuses formed by nature, or by *habits of application* for these abstruse studies, whereas the way of experimental popular lecture is fitted to almost any capacity; and would lead many into a clear insight of those and other arts who would otherwise pass the remainder of their life deterred and disgusted by the methods of dry geometry."

"But unfortunately for them and for the service, should they neither find proper instruction nor employment as Artillerists, nor hope of other distinction but what is got by seniority, nor appearance of any other merit but longevity being rewarded, it would not be surprising if they should grow daily more and more indifferent about improvements of any kind, and about the service in general: provided they could in peace and tranquility live out those long days that so slowly bring on their preferment, or that they should keep secret to themselves any little information that they might by chance or natural curiosity acquire; hence private knowledge becomes not of any public benefit. The hints of many ingenious Artillerists have been either too slightly pursued, or passed over without notice, and whatever taste or abilities for this art any Officer in a subordinate station may possess, what can he expect, after seeing the improvements of a Robins, a Muller, and a Desaguliers totally neglected; such a Corps will want sufficient principles of activity, and each will *gravitate towards repose*."

"Proper methods are wanting in almost every branch of the service of collecting and preserving for the use of others, a sufficient knowledge of what

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nas been thought of or done before. On the ideas of men being transmitted to their successors depends the progress of every art—had good accounts of what has been formerly proposed and done in the military arts; of the changes and reasons, &c., been continued and preserved in some accessible place, such a collection might contain much useful information; and young Officers would not remain as now totally at a loss where to look for any."

* * * * * * * *

"In the military school, however imprudently we confine our lower ranks to little trifling and disgusting duties,* surely to all above those who manually execute, the way should be open, and invite to general military knowledge, and to every art or science connected therewith. Theory and practice should be brought acquainted in proportions as they seem to fly from each other; pursuing the same ends from the same principles, may long remain in their present incommunicable state, almost unintelligible to each other; while even Officers divide into advocates, some for practice and others for theory; and with a kind of mutual contempt vainly contend for a superiority between things which must ever be mutually dependent on each other, and ought to be divided in the rank we now speak of."

"The changes here indicated may be thought too great for execution, such excuses will be used long after they have ceased to be true. Such improvements may be at any time begun."

He proceeds to lay down a plan for the general instruction of the regiment, and direction of all the practical branches of the service—to be given to "one or more Officers of noted military learning and experience," next under the Master-General, and to be assisted by subordinate masters, &c., &c. He proposes the annual formation of a park at different places proper for practice—which should previously be all planned and the objects of it made known. The whole to be carried on under the immediate direction of these masters. The remainder of the tract is occupied with visionary details and proposals, admirable in themselves: but too little consistent with the realities of the service, for realization.

The following is a List of the other Papers of the Society which are preserved, and it serves to give an idea of their proceedings.

(No. 1.)

1. Mr. Shand's Paper on Arches, read 5th December, 1772.

2. Lieut. Jardine's Remarks for the determination of the best length of guns, &c. 3rd April, 1773.

To find a long gun and bore vents at different lengths, filling up the space behind, &c., &c.

3. Proposals for experiments to determine if possible the best length of pieces of ordnance—also a scheme of application to the Board of Ordnance for ammunition necessary for experiment, by Lieut Dorset. 3rd April, 1773.

* The preceding paragraphs animadvert on the bad system of instruction pursued with reference to Soldiers.

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To find a long gun, say 30 calibres, and saw off half a calibre at a time, &c., &c.

4. Proposals to the Military Society relative to experiments with Grape Shot, with a design to determine the fittest calibres, the charge, &c., for that method of firing, by Captain Smith. 3rd April, 1773.

Thinks small guns are fittest.

5. Proposals for ascertaining the proportionate strength of Powder, by Lieut. Dorset.

To make accurate experiments with some one powder as a standard for others, (this is the system of the French.)

A Paper Wanting.

7. Capt., afterwards Sir Thomas Blomefield on powder and artillery. p. 38.

Among other propositions, "that the tangents for every ½ degree of elevation be calculated from point blank to 6°, according to their different lengths, which graduated upon a small scale with sights might be fixed or occasionally applied to the base ring. This was the origin of our present mode of pointing.

8. A scheme of experiments by Michael Dorset to disprove Robin's notion of the instantaneous inflammation of powder. Observes that "we are practically wrong in supposing the utmost range of our mortars to be 45° when from the pressure of a resisting medium it seems to be lower." There are many valuable hints in this paper.

9. Proposals for an experiment by Captain Jardine, July 29th 1773. Thin targets of papers to be erected at different heights, and musket balls fired through them to determine path of projectile; experiments for the penetrations of shot; to fire shells at high and low elevations, to try how near they fall to each other, and test the parabolic theory; to ascertain the angles of Incidence of the shells by making them fall through a sheet supported horizontally high from the ground .

10. Proposed Experiments for Strength of Powder, submitted to General Desaguliers. Tenth Meeting, 31st July, 1743.

11. Description of Two New Instruments for Laying Ordnance, by Lieut. Dorset.

An application of the Quadrant and a Tangent Scale with Spirit Level to be applied to the base ring, (something like the spirit level used for mortars.)

12. Remarks on the above by Captain Jardine.

A Paper Wanting.

14. Mr. Lockie's Specimens or Heads of a Lecture on Fortification.

15. Experiments by Count la Lippe with a falconet of 20 cal.: carrying a leaden ball weighing 23 oz. on penetrations.

A Paper Wanting.

17. Remarks upon the construction and use of artillery by an Officer of the Austrian Service, communicated by Major-General Desaguliers. (French.)

18. Paper on the subject of Mr. Robins, 9th Proposition. 16th November, 1773.

19. Experiments 29th Nov. 1773.

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Light 6-pr. of 4½ ft., 5cwt. 1qr. 2lbs., iron 6-pr. shot and leaden ball weighing 9lb. 15oz.; penetration of iron shot into earth at 23 yards was 4ft. 10⅓in. with 1 lb. charge, and 6ft. 5⅔in. with leaden shot. The greatest penetration with 1lb. was within 3 inches of the greatest penetration with 1½lb., the same appeared on another occasion. Captain Smith.

20. A paper by Mr. Verbruggen, (Foundry Department.) Dutch.

21. On the Arch of Equilibration of Powder Magazines, by Dr. Hutton, 22d January, 1774.

23. Letters from Captain Blair to Captain Jardine, 26th April, 1774 and June 17th, 1774. Description of the Carron Works, saw a 24-pr. proved with 16 lb. charge and 9 shot, with a wad over each, then with 18lbs., same shot, gun 47½ cwt. and 8ft. 11in. long, "what is become of the German who was to make rifled field pieces?" Saw a 32-pr. of 45 cwt., 9ft. 4in., proved with 24 lbs. charge and six balls—unhurt. "Where Iron Guns are proved I think no more powder should be used than on real service, and that its effort to burst the gun should be increased by adding more weight or resistance before the powder, such as a greater effort is made against the part of the gun meant to sustain it, whereas when the quantity of powder is increased it reaches so far that the greatest effort is made against a part which is not meant to sustain it." Shortly before this on the death of Mr. Roebuck the Carron Guns had through the carelessness of the workmen very much deteriorated, and the firm lost ground, his successor, Mr. Gascoigne was now trying to regain and extend their credit, in which he succeeded.

24. Dr. Hutton in continuation of No. 21. 23rd April, 1774.

25. Proposed experiment on Powder by M. Dorset. May 21st 1774.

26. Same subject by Captain Bloomfield. Read May 21st 1774.

27. Extracts from Antoni's Examen de la Poudre.

28. Experiments with Cylindrical Shot, 18th June, 1774, on Woolwich Common by the Military Society. Shot were of this shape [_____), weighing 20 lbs. and diameter of a 6-pr., object a small round target. Charge 1 lb., 3 rounds, fired at 100 yards, 2 missed; 1 at 150 yards hit, 2 at 50, hit.

29. Experiments with several sorts of Powder, 20th October, 1774. 15 sorts, royal mortar, charge 2 oz., extreme ranges, 185 yards.

30. Captain Jardine on Artillery, addressed to Col. Pattison. "After our yearly practice I commonly try to discover what general conclusions can be drawn from thence—considering it as consisting (or that it ought to consist) of experiments intended to furnish instructions to Officers, in the acquisition of general ideas and principles, as well as to the men in the execution of every particular part. Science is generally simple and easy, but its substitutes perplexed and difficult. Men are formed by their occupations and pursuits, if we can but occupy them and interest them, or rather induce them to occupy themselves, in things that require activity or ingenuity they will be active and ingenious, but the grand art of exciting men to great and useful exertions requires that they should be employed and trusted in things of some importance and utility, for there is no interesting men sufficiently about trifles, especially when they discover the intention to be merely that of filling their time, by this means, men of merit who feel themselves fit for

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much more important purposes, are teazed and disgusted, while the rest become still more callous and indifferent, and as it were assimilated to the frivolity of their occupation. If we, for example, during some long peace, should ever be in such a situation absorbed in indolent security, or totally confined to some troublesome routine of unmeaning minutiæ; in that case the corps cannot long continue to produce Officers fit to serve with reputation, or Field Officers capable of going out of the common track, or of supplying any of the many defects of our Military Institutions."

He gives some tables of Mortar Practice, with a view to determine the limits of uncertainties in firing, according to the practice of that day; then adds:

"Without some such general idea of the limits of those deviations no judgment can be formed of the power of our present Artillery, nor of the merits of any future improvements, &c."

"I have some reason for believing that our present mode of directing pieces with the plummet and chalk centre, besides being very tedious, is not capable of pointing them at a medium nearer than within ½ a degree of the line or object."

	yds.	Deviat.		Range.	Deviat.	
which at	300	= 5 yds.	at	1000	= 18 yds.	laterally,
and if we suppose an error in elevation of ½° under or over, being a difference of 1°	„	= 5 yds.	at	„	= 18 yds.	in range.

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MINUTES OF PROCEEDINGS

OF THE

ROYAL ARTILLERY INSTITUTION.

Special General Meeting, 16th December, 1844.

Major.-General Sir HEW D. ROSS, K.C.B., in the Chair.

Resolved,—

THAT this meeting approves of the principle of appropriating a certain portion of the funds of the Institution towards providing instruction in foreign languages of general professional use, provided that a portion of the expense (the amount of which shall be arranged from time to time by the Committee) be defrayed by the particular members availing themselves of the instruction.

Annual General Meeting, 30th June, 1845.

Lieut.-General Lord BLOOMFIELD, G.C.B. and G.C.H., in the Chair.

1. The Report of the Committee for the year 1844 was read.

2. The following officers were appointed members of the Committee for the year 1845-46, viz.—

Major-Gen. WEBBER SMITH ...	2nd	year of appointment.
Sir JOHN WEBB	3rd	„ specially appointed.
Lieut.-Col. DANSEY	2nd	„ of appointment.
Lieut.-Col. BROWNE	1st	„ *vice* Col. SWEETING.
Lieut.-Col. COLQUHOUN	1st	„ *vice* Capt. TAYLOR.
Capt. GRANT, R.H.A.	2nd	„ of appointment.
Capt. COCKBURN	1st	„ *vice* Lieut. GARDNER.
Lieut. ROSS, R.H.A.	1st	„ *vice* Lieut. BOXER.
Lieut. GRAYDON	1st	„ *vice* Lieut. RIDDELL.

3. Lieut. Riddell was appointed Secretary and Treasurer.

4. The thanks of the Meeting were voted to Captain Gore for his exertions during the years he had filled the office of Secretary.

5. The accounts for the year ended 30th April, 1845, were laid before the meeting and passed. The following is an abstract:—

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Abstract of Accounts for the year ended 30th April, 1845.

Income.	£	s.	d.
Balance Credit, 1st May, 1844	101	7	4½
Annual Subscriptions of Members	126	10	0
Entrance ditto of ditto	19	15	0
Back ditto of Lt.-Col. Sabine.....	0	7	6
„ „ „ Blachley.....	0	7	6
„ „ „ Gray (1843)	0	7	6
Subscriptions by German Class ...	5	15	0
Dividends to 5th January, 1845 ...	4	10	0
	£258	19	10½

Expenditure.	£	s.	d.
Altitude and Azimuth Instrument	24	0	0
Books, Binding, Stationery, &c.....	12	1	10
German Instructor, to 31st March, 1845	12	10	0
Insurance	3	12	9
Purchase of Stock	19	17	0
Donation to Serjt. Yates (clerk) ...	10	0	0
Unpaid Subscriptions	4	5	0
Clerk's Salary, at 1s. per day...	18	5	0
Fuel and Incidents	15	8	1
Furniture and Fittings	5	17	9
Repairing, &c. of Instruments	8	0	8½
Balance Credit	125	1	9
	£258	19	10½

Ordinary Monthly Meeting, 1st December, 1845.

Lieut.-General Lord Bloomfield, G.C.B. and G.C.H., in the Chair.

1. The Resolutions passed at the General Meeting of 1842, as to the communication and printing of Papers on professional and scientific subjects, were read, viz.—

1st. That the members of the Royal Artillery Institution be invited to contribute papers on subjects of scientific and professional interest.

2nd. That these papers be addressed to the Secretary; and, after being examined by the Committee, shall be read at the next meeting of the Institution, or as soon as convenient.

3rd. That no papers shall be read without the sanction of the Committee.

4th That the Committee shall have power to select annually from those that have been read, such papers as they consider it desirable to have printed at the expense of the Institution.

5th. That one copy of the papers so printed be supplied to each member.

2. Read,—A letter from Dr Robinson of Armagh, to W. Caffin, Esq., Chief Clerk of the Laboratory Department, dated August 15th, 1840, communicating the result of experiments with two 12 lb. and two

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24 lb. rockets, made with a view to their use in determining the difference of longitude. The result of the particular trials were as follows :—

	lbs.		Seconds.		Seconds.		yds.
No. 1,	12	Fuse	8	Flight	14·8	Height	2,079
2,	12	„	9	„	15·	„	1,991
3,	24	„	9	„	22·4	„	2,533
4,	24	„	10	„	26·	„	2,800

No. 4 turning and throwing its stars at 2579 yds.

Dr Robinson's conclusions (which appear to refer to other than these four experiments) are, that the 12 lb. rocket, with the weight of heading used, will do best with a fuze of 7 seconds, the height with 6 seconds and 8 seconds having been nearly the same; and the 24 lb. rocket, with a fuze of 9½ seconds, or such a one as will make the whole time of flight 24½ seconds.

He also adds, that for the observations of longitude, he is satisfied that the 12 lb. rocket, with 1 lb. of powder in the head, (which head, he says, need not be stronger than those of his trial rockets,) are exactly what is required.

On the Transport of Heavy Burthens upon Ice; communicated by Lieut.-Colonel F. Macbean, R.A.

This paper contains the particulars of the transport of a 24-pounder gun across the Hudson, on the 13th January, 1835. From the place of departure, where the experiment was carried on, the ice was drilled through at intervals of 200 paces, from thence to the channel of the river, the thickness diminished from 16·5 inches to 8 inches, and no signs of cracking or bending were observed; the load moving at the rate of about 8 miles an hour. Near the entrance of a creek, the ice for 50 paces averaged only 5·56 inches, and was covered with a sheet of snow-water 2 inches deep; this part of the ice bent much, and had the load stopped but for a few seconds, it would have sunk; the depression here was 2 inches, the horses moving at about 4 miles an hour, being tired.

Weight of the gun, 5579 lbs.; the timbers, lashings, sleds, &c. 1624 lbs., making in all 7203 lbs.

The whole surface of ice, in contact with the bottoms of the runners, was 6·458 square feet, consequently the pressure sustained by each square foot of ice, was equal to (7203 lbs. divided by 6·458) 1115·361 lbs.

From the observed effects upon the 50 paces, a good estimate may be formed of the least thickness upon which we may bring a pressure of 1115·361 lbs + 10 lbs.) = 1125·361 lbs.; the 10 lbs. additional being

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allowed for the covering sheet of water, whence it is evident that ice will not be safe if its thickness be not above 5·56 inches.

The paper concludes with the following inferences :—

1st. That a load may be transported with perfect safety over sound ice 8 inches in thickness, by distributing the entire weight of the system, so that each square foot (in contact with the bottoms of the runners) shall not experience a pressure of more than about 1115 lbs.

2nd. That a load *cannot safely be transported* over sound ice 5·56 inches thick, when the weight is so distributed, that each square foot of surface, in contact with the bottoms of the runners, has to sustain a pressure of 1125 lbs.

N.B.—To this paper may be added a circumstance perhaps not generally known with regard to ice, that by placing a layer of straw over it, throwing water upon that, allowing it to freeze, then another layer of straw, and again water, the thinnest ice may be made to support great burthens.

Notice of the two Great Fires at Quebec, in the Year 1845.

By Capt. Warburton, R.A.

On the 28th May, 1845, at ¼ to 11 A.M., there was an alarm of fire in a tannery in the suburb of St Valliere; this was so common an event at Quebec, that at first it attracted but little attention. The danger quickly spread, however, and the increase of the wind, which coming from the south-west, directed the fire upon a large and populous district of wooden houses, soon made evident the extent of the danger. The fire-engines of the Insurance Companies were soon at work; but from the scarcity of water, and the feeble and ill-directed efforts of the workmen, they were useless. At about ½ past 1 P.M., by the orders of the military authorities, the Royal Artillery engine reached the spot, but by that time the wind and fire had attained such strength, that it was plain that the only means of arresting the disaster was to make gaps in the communications of the buildings, which the artillerymen attempted to effect with axes and crow-bars, the civil authorities having objected to the more rapid and effectual process of explosions. Detachments of the 14th, 43rd, and 89th regiments arrived soon afterwards, and all exerted themselves with zeal and courage, and were the means of saving many lives. At 3 P.M., the wind (probably nursed by the fire) increased to a hurricane. The flame raced

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along the streets. Blazing shingles and rafters were whirled through the air, and where they fell far away to leeward new fires sprang up, and hemmed the people in, and they perished. Palace gate was the only opening into the walled town on that side; the soldiers all got in safely by running rapidly, the fire then closed upon everything outside. The Artillery Barrack is in an angle of the town, across which the path of the fire lay, but it is protected by a glacis and walls of considerable height and thickness; the nearest buildings were roofed with tin, part of which melted and dripped from the walls. The grass on the ramparts was burnt up like straw. The mess-house and wooden railings and out-buildings higher up in the yard were frequently on fire; a heavy shower of rain, a supply of water, and active and numerous hands finally saved them, and with them the upper town. The fire had now reached the beginning of lower town, the heat and sparks had set fire to the wooden copings and gun platforms on Rampart-street; the magazine was close inside, its contents 179 tons of powder. Wet clay was heaped against the door and windows, the stone and metal became too hot to touch; after some time the wood-work in the neighbourhood was pulled up and thrown over the ramparts by the soldiers, and in that place the fire exhausted itself. At 8½ P.M. (the Mayor having consented) Major-General Sir J. Hope, by the advice of Lieut.-Col. Ward, Royal Engineers, ordered Captain Warburton and Lieut. Shakespear, R.A., to blow up a wooden house in Canoterie-street, where the town narrows into a neck between the walls and the river. A barrel of L.G. 100 lbs. was covered with a wet blanket; the top was bored with an auger to admit a 4-inch portfire, secured in its place with wet clay. The retreat was sounded and carefully enforced, two gunners carried the charge into the house, a serjeant fired it under the superintendence of the officers, in four minutes the explosion took place, the house was destroyed, the roof blown up, the walls collapsed. The gap thus made was insufficient; the order was given to destroy the next building, which was stone, and of great solidity. While the charge was being prepared the house took fire, which increased the delicacy of the operation: a barrel similar to, and prepared in the same manner as the first, was placed on the ground floor against a projecting shoulder of the chimney wall, forming a stone cupboard, the portfire was lighted, and the party came away through the window, the door passage being on fire; after the same interval as before the explosion took place, the destruction was complete, no stone was left upon another; for many seconds afterwards the wind was stilled, and the fire weakened. By clearing away the ruins and some timber in front, further communication was stopped. The fire was not at an end till 2 A.M.

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the 29th. As nearly as can be ascertained there were 1630 dwelling-houses burnt, 2000 stores and out-buildings; 27 remains of human bodies were found. The total of missing was 61. Many more must have lost their lives; where whole families were burned, there was no record of them. There were no casualties among the military

On the 28th June following, at ½ to 12 P.M., a fire commenced with the suddenness of an explosion, immediately outside the walls of the town, where the last had ended on the south side, and as a gale of wind was blowing from the north-east at the time, the flames soon spread with frightful rapidity through the suburb of St John, in which the greater number of buildings were wooden. This was immediately outside the walls of the Artillery Barracks, but as the wind was from thence, they were not threatened, and their engine and the detachment R.A., were the first on the spot. It was however at once evident that the whole district to leeward was doomed; no water could be obtained, the intensity of the heat and the clouds of dust rendered all exertions both painful and unavailing; the inhabitants at once deserted the town, carrying with them the sick and infirm, and their most precious and portable goods, and took refuge behind the fences in the fields in the country, no effort was made by them to save the town, they were overcome by apathy and despair. The soldiers (all had now arrived) exerted themselves with the same courage and energy as on the former occasion, and in several instances there were narrrow escapes of being shut in by the sudden spread of the fire. At about 3 A.M., 29th, the Major-General (Sir James Hope) determined to attempt cutting off the progress of the flames to windward, by blowing up a strong building of brick. The charge of powder, and its mode of preparation, the same as at the explosions in the last fire; the house was totally destroyed, and the rest of the street saved. A curious difficulty arose when the powder barrel was duly placed, of getting the portfire lighted to fire the charge; though on the edge of half a square mile of fire, the heat was so intense that no one could approach within many yards of it; after a delay of several minutes, an eddy of wind threw some portions of burning shingles within reach, and the object was effected, but not before the house had taken fire, and some straw around the powder was blazing. No. 2. The charge was placed in the corner of a wooden building behind the street, but from the badness of the portfire, it did not explode until the house was partially burned, and had in consequence but little effect. No. 3, was the explosion of a stone cottage, the barrel was put against the chimney, the building was razed, but this proved of no ultimate benefit, as the houses on the opposite side of the street had been fired in the mean time by a

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slight change in the wind. No. 4. A methodist chapel of great strength was destroyed, but without result from the same cause as the preceding. Nos. 5 and 6 were stone houses, partly separated from the others in the street running S.W., which explosions had the effect of stopping the fire in that direction. No. 7 was a stone building; here also it was successful. No. 8 was a wooden building, which it was judged neeessary to destroy, as the progress of the fire was so rapid up the street, as to make it appear impossible to save the lower part of it; the barrel was placed in a cupboard, and the houses next, and opposite to it, were with it destroyed. Nos. 9 and 10, were wooden houses at opposite corners of a street running S.W.; both were destroyed, but the spread of the fire rendered them useless. No. 11 was a wooden building with a stone foundation, the charge was placed against the chimney. No. 12 was a stone house on the opposite side of the street to the last. These two explosions stopped the fire in the street, and soon after the troops were withdrawn, the flames having exhausted themselves. In all cases the charges were prepared, as I have described for the first fire, the portfires varied from 4 to 7 inches; all these precautions were needed, as in several instances the houses were on fire when the charge was placed in them, and from the extreme heat and the violence of the wind, which carried flakes of fire in all directions, there was some difficulty experienced in conveying and properly placing the powder-barrels. The efforts were united to stopping the fire to windward, elsewhere exertions were useless. The gale increased during the fire, and carried with it such clouds of dust, as almost to suffocate those who were working. The fire ended at ½ past 8 A.M. In spite of all precautions, owing to the darkness of the night, and the obstinacy of some of the people, at No. 1, a man had his thigh broken, and at No. 9, another was killed by the explosions; there was no more loss of life. A few soldiers were slightly burned; 1512 houses were burnt. The amount of damage in both fires is stated at £1,400,000. On both occasions very large subscriptions for the sufferers were raised among the residents and the civil and military bodies in Canada.

A barrack was thrown open, tents were pitched on the glacis, and rations served out by the Commissariat. Every effort was made by those who had it in their power to lighten the weight of the terrible calamity which had fallen on 21,000 of their fellow subjects. The orders issued on both these sad occasions by the Commander of the Forces in Canada, give evidence of the estimation in which the exertions of the garrison of Quebec are held by the military authorities and the inhabitants.

The explosions in the latter fire were conducted by the same officers as on the first occasion; all the charges were lighted under their immediate direction.

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Ordinary Monthly Meeting, 31st December, 1845.

Col. TURNER, C.B. in the Chair.

Remarks on Casemated Batteries in general, and their special application to Sea Defences; with some observations on the armament and service of Sea Batteries. By Capt. WILFORD, R.A.

Casemated batteries and towers are now generally introduced into projects for permanent works. They are, so to speak, in fashion, and are especially advocated for sea defences. Some officers go so far as to say, that no battery which has a less command than 50 feet over the sea can be served with effect against ships of war. Under these circumstances, and seeing the vast expense of casemates, it is well to inquire whether they really possess the advantages so confidently attributed to them.

The question rises in importance at a time when we are engaged in fortifying our coasts and harbours; any serious mistake in such a matter is of vital importance to the country.

Continental engineers, particularly the Germans, having been called upon since the Peace of 1815, to construct permanent works calculated to arrest the outbreaks of French ambition, have made large use of casemates. Dissatisfied in common with all reflecting military men, at the defences made by fortresses constructed on the principles of Vauban and his followers, they have sought by modifications of the ideas of Montalembert and Carnot to obtain a system which shall be capable of longer resistance. To accomplish this object their chief dependence seems to be placed in casemated fire, and it is believed they have in some cases adopted two or three tiers of gun casemates. It is however to be remarked that these new fortresses have yet to be put to trial. They are but an experiment; their mere construction is no *proof* that they will answer; Carnot imagined his detached wall with its *couvre* face of earth could not be breached from a distance. We saw it battered down in one day's firing.

Casemates appear to be open to the following general objections:—

1. As usually constructed, they necessarily involve the very great disadvantage of a brick or masonry parapet. Every shot that strikes within the mouth of the embrasure will be deflected from the cheeks and must carry with it, as into a funnel, fragments of the work more destructive than the shot itself.

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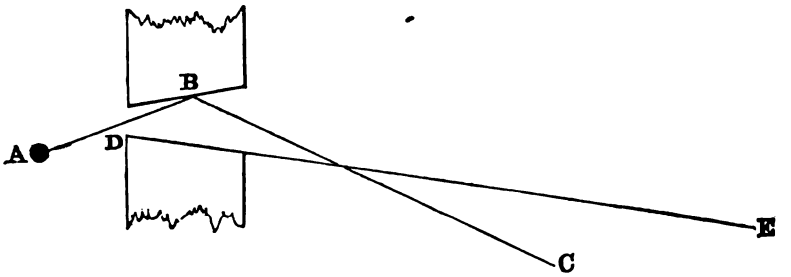
Shot, that otherwise might pass clear over the heads of the gunners, in the casemate will be deflected downwards by the roof or crown of the arched embrasure.

It is to be remarked, that the casualties occasioned by shot or shell entering the casemates will be greatly increased, if they are closed to the rear.

Even should the shot pass through or bury itself in the rear wall, the fragments which would fly out on impact would be most destructive. A shell bursting *in* the rear wall or after rebounding from it, would probably put the whole gun detachment *hors de combat.*

Imperative engineering considerations may render this construction indispensable; but it, nevertheless, impairs most essentially the efficient serving of the batteries by the artillery, if exposed to a well directed fire of shot and shell.

2. Casemates are liable to receive a fire which they cannot return. The enemy's shot being deflected from the cheeks of the embrasures into the casemates, in a manner they could not be, if the cheeks were of earth.



ABC, path of a shot fired from a point C outside of DE, the prolongation of the right cheek of the embrasure. Hence a gun at C would be secure from the fire of the casemate, which could yet receive the shot from C.

3. The space within casemates is much confined, which is always disadvantageous.

4. The supervision of several pieces by one officer is more difficult than in an open battery.

5. The smoke, depending upon the state of the atmosphere at the time, must be more or less inconvenient.

6. The construction of casemates is very expensive.

7. As to the superior fire of two or three tiers of casemates, they can be silenced in succession by so directing the soles of the embrasures of the besieger's battery, that his guns shall be exposed to the fire of only

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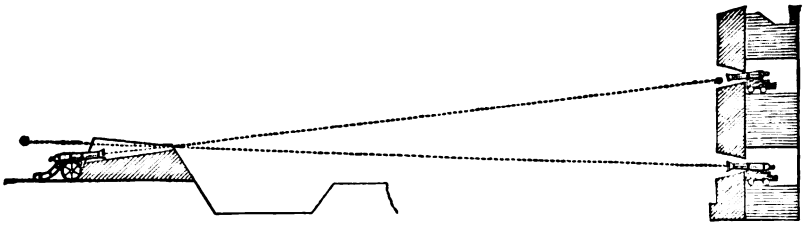
one tier at a time, as will be evident from the inspection of the following sketch, which is not made to any scale, but exhibits the principle.



In proof of the most serious of the foregoing objections, the following extract from Sir John Jones's "Journal of the Siege of the Castle of Scylla" is transcribed. That distinguished officer, at page 406, Vol. II. of the second edition of his work entitled "Journals of Sieges in Spain," (that of Scylla being introduced), has inserted the following note:—

"On examining the interior of these casemates whilst the terms of surrender were still copying out fair, and consequently before steps could be taken to clear or purify the castle, it was altogether surprising to observe the mischief which had been occasioned by shot which had deflected from the cheeks of the embrasures and entered the casemates.

"To judge from the indentations on the walls and the marks of slaughter and destruction which everywhere presented themselves, a direct fire into a casemated embrasure of the usual construction must render casemated batteries untenable; indeed, at this attack, the French loss was chiefly by shot which entered the embrasures and passed through the rear of the casemates.

"Such batteries should, therefore, be confined to situations where the embrasures can only be seen in the direction in which the guns can be pointed, or else the engineers ought to guard against the action of shot deflecting from the cheeks, which surely would not be difficult to accomplish where the fire of the batteries is, as in most works of defence, for a specific and limited object; or, perhaps it would prove more effectual, and it might be accomplished in most situations where direct fire is only required, such as a causeway, the entry of a port, or a particular tongue of land, to cause the gun to fire through a second opening made in a screen in its front, and then no shot could, by possibility, strike the embrasure, unless fired almost perpendicular to the two openings." The note is given entire.

The remedies suggested by Sir John Jones, show how strongly he felt the inefficiency of ordinary casemates. It does not appear how he could propose to guard against the deflection of shot from the cheeks of the embrasures.

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The erection of a screen with openings corresponding with the embrasures, must in many cases be impossible, and, under almost all circumstances would inconveniently limit the action of the guns. It is not meant to be contended that casemates are useless and altogether to be rejected; on the contrary, in particular situations they are most valuable, such as against a land attack, where the artillery of a fortress is liable to be silenced by heavy vertical and richochet fire. Bomb-proof cover, even if temporary, in the form of blinded batteries, is highly necessary for the guns flanking the ditches of the front attacked, and is more especially applicable where the guns so covered cannot be counter-battered from a distance. But it is believed, an extensive adoption of casemated systems, whether for land or sea defences, is not yet justified by experience.

As regards the special adoption of casemated batteries for sea defences, it would seem, on the one hand, that casemates labour under the same general disadvantages when opposed to the fire of ships of war as when attacked by land batteries, and on the other, that the vertical and ricochet fire of a fleet, can seldom be so accurate or generally formidable as to make it an object to put the ordnance of sea defences under bomb-proof cover. It is, indeed, asserted that if the guns have not a great command, or be not retired from the shore beyond the range of musketry, the gunners will be driven from them by a fire of small arms from the tops, when the ships come close in. In the first place, it is not often that heavy ships can come within the effective range of small arms. Secondly, an artillery that knows its duty will, in all possible cases, commence its fire long before ships come within so short a distance. Thirdly, the very smoke from the ship herself, to say nothing of that from the battery, would probably prevent accurate aim being taken.

Besides, when a ship is merely exercising her guns in smooth water, the motion is considerable and must be felt in the tops, and the same effect will follow in action. Moreover, what is to prevent the musketry from the troops being opposed by similar fire from the works, or it could be met by case-shot from a field piece. Field rockets (Congreve) fired at the tops and rigging, might be of great service against the sailors and marines aloft. It is doubtless desirable that sea batteries should have certain command, and in cases where the depth of water allows ships to closely approach the shore it is certainly advantageous, where localities permit, to withdraw the batteries beyond the point blank range of heavy guns.

It is well known how tremendous is the fire of ships of the line, and it is hence advisable so to dispose the batteries that ships shall be obliged to resort to a divergent fire, and be themselves exposed to a concentrated fire from the batteries. It is true, that in particular situations where space is

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limited, casemates do afford the means of having two or more tiers of guns, the upper tier being, if thought proper, on an open battery; and, moreover, that these different tiers are not liable to be silenced in succession, in the manner shown to be possible when the attack is from the land. However, it is believed, that this arrangement should, if possible, be avoided, that the same number of guns would contribute more to the defence if placed in one tier but on a more extended front. Finally, it is thought that, as a general rule, no advantage attends casemated batteries for sea defences at all commensurate with the many drawbacks upon them; and that, unless in special cases, the ordnance had much better be placed in ordinary batteries, provided with good earthen parapets of at least 20 feet thick and 7 ft. 6 in. high, or even higher, if the command of the work over the sea be small. Although 18 ft. be the usual thickness of the parapet, 20 ft. is recommended for sea batteries, in consequence of the heavy armament, including shell guns now universally adopted for ships and war steamers. In situations where earthen parapets are liable to be destroyed by the wash of the sea, stone or brick parapets must necessarily be used. The casualties arising from the enemy's shot may be in part prevented, by covering the superior slope with a double course of sand bags. Enfilade and ricochet fire from ships can be parried when the batteries are deemed liable to such modes of attack, by permanent and lofty traverses.

The vertical fire of a fleet may injure towns and dockyards, but cannot, it is imagined, be effectual in silencing batteries, and therefore does not require to be specially provided against, by putting the ordnance of sea batteries into casemates.

Armament of sea defences.

As regards the armament of sea defences, the general rule seems to be, that in all situations of importance, the ordnance should be of as large calibre as can be conveniently worked. The following pieces call for particular remark:—

13 and 10-inch sea mortars.

May be deemed most useful in preventing hostile fleets from lying at anchor within the distance of their most extreme range.

13 and 10-inch land service mortars.

May, as well as sea mortars with reduced charges, be of service against a fleet at anchor, and engaged with sea batteries. It is difficult to see how a good mortar battery could be silenced by shipping, and yet when the range was once ascertained, the fire of the mortars would be most effective against a fleet at anchor. The horizontal projection, or the section of a first-rate ship at the line of flotation, is about 10,000 square feet of superficial extent; the mark is therefore large.

10-in. guns.

Are most eligible pieces for sea defences.

The diameter and weight of the shell, and its explosive effect when *filled* with powder, must have most destructive effect upon any vessel.

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The 10-in. gun of 9 ft. 4 in., 84 cwt. may be fired with advantage through an embrasure from a dwarf traversing platform, or from a traversing platform, *en barbette*, over a parapet. By means of a bearer the shell, though heavy, may be readily raised to the height required to load. The 10-in. howitzer is too short to fire through an embrasure. Our battering ordnance generally is shorter than the French, and is hence more destructive to the embrasures. *En barbette*, from a traversing platform when the desired range is not very long, the 10-in. howitzer would probably be most effective; 10-in. concussion shells, and possibly carcasses, would have an excellent effect.

10-in. howitzer.

The 68-pr., 10 ft. 10 in., is doubtless most effective when a very long range is required. A few may be wanted to sweep the sea, and keep bomb-vessels and steamers at a distance.

68-pr. 10 ft. 10 in.

The 56-pr., 11 ft., may be employed for the same service as the 68-pr., 10 ft. 10 in. It seems, however, objectionable, as causing a needless complication of ammunition. It appears doubtful with regard to both pieces whether they possess advantages in accuracy over the long 32-pr., so great as to counterbalance their increased weight and expenditure of ammunition, unless an object is to be attained by throwing shot to an extraordinary distance.

56-pr. 11 ft.

The 8-in. gun, of 9 ft., 65 cwt., is an excellent gun for sea batteries, particularly for firing through embrasures and where the range is considerable. The 8-in. gun, of 6 ft. 8 in., 50 cwt., appears to be much preferable for firing through embrasures, to the 8-in. howitzer (but 4 ft. long); both may be used for firing *en barbette* from traversing platforms.

8-in. guns.

Are generally thought excellent guns for sea batteries, combining considerable weight of shot with accuracy and long range. This gun appears to be scarcely heavy enough for its weight of shot and service charge. It is very lively when fired from a garrison carriage on a stone platform.

32-pr. 9 ft. 6 in.

May be used to fire shot or shell when the range is short.

Appears preferable in one respect to the 32-pr., 9 ft. 6-inch. being a much heavier gun in proportion to its shot, and hence its recoil is less violent.

32-pr. short bored-up guns.

24-pr. 9 ft. 6 in.

Can be used like the short 32-pr., and generally against small craft and boats in situations not liable to attack from large vessels.

24-pr. short bored-up.

Useful for long ranges when not exposed to the attack of heavy ships.

18-pr. 9 ft.

May be required to aid in coast defences. The calibre must be determined by circumstances, such as state of roads, nature of country, means of the enemy. They must be capable of moving rapidly from point to point, to oppose disembarkations and to protect our own vessels, merchant or otherwise, according to circumstances. Perhaps batteries exclusive of

Field batteries.

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field howitzers would be best for this service; they might be provided with some rounds of hollow shot for quick firing.

Mode of mounting guns on sea defences.

In almost every situation it is desirable that ordnance on sea batteries should be mounted on some description of *traversing platform*, for the double purpose of running up and traversing the gun with ease and celerity. Where the gun is not required to be traversed through a considerable angle, it is perhaps best mounted on a dwarf traversing platform to fire through an embrasure; where a wide sweep is necessary, the gun will be best on a traversing platform high enough to allow it, as is usual, to fire *en barbette* over a parapet 6ft. high. The common standing carriage, on a ground platform, is not convenient even when the channel to defend is narrow in consequence of the comparative slowness with which it can be run up and traversed. Where the garrison carriage is resorted to with ground platforms of stone, the part of the platform on which the gun stands when run up to be pointed, might be made with a slope, barely sufficient to carry off water, the rest might have a much greater slope than is usual in order to stop the recoil. Sanding the platform and laying sand bags a few feet in the rear of the hind trucks, will effectually check the recoil.

Sea batteries in important situations should be provided with ample means for speedily changing a disabled carriage, and remounting a gun if dismounted by an enemy's fire. Ships possess this facility, particularly on their lower decks. By means of tackles and ring-bolts over head, they can change a disabled carriage in a very short time.

On board Her Majesty's ship "Excellent," this operation is habitually performed in less than two minutes.

Sights.

Sea batteries being required to fire as rapidly as is consistent with precision, it is requisite that the ordnance mounted on them should be fitted with the very best means for giving them the required line and elevation with celerity and accuracy. The objects, moreover, at which their fire is directed are frequently in motion, and hence no time is to be lost.

It is conceived that the dispart sights and brass tangent scales, provided for naval guns, constitute the best means yet devised for laying guns quickly and correctly, and that consequently all ordnance on sea defences, should be fitted with them.

The expediency of some such arrangement for the 8-in. gun, 65 cwt. is most apparent. The dispart of the gun being 2½ degrees, and the only means yet provided for giving any less elevation, being the degrees marked on the second reinforce and base-rings. It is to be observed, that this graduation does not extend to half degrees, and that the visual line

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between the notches on the base and reinforce rings is so short, that even degrees of elevation cannot, it is imagined, be given with accuracy.

Let any officer direct a gun without dispart sight and tangent scale, and mounted on a garrison carriage, to be laid at a ship or boat under sail although making but little way, and it will be evident to him how inefficient is the whole arrangement for the rapid and correct serving of the gun.

Projectiles, shells.

Concussion and percussion shells, when brought to the desired degree of perfection, will no doubt prove highly serviceable against shipping. But the common shell filled with powder and a proportion of Valenciennes composition, and fired with a somewhat long fuze and a charge proportionate to the distance of the vessel, would be most formidable.

Hollow shot.

Hollow shot can be fired from the large calibres, either cold or red-hot. If a very small hole be drilled into them to allow of the escape of the air within, which would necessarily expand from the heat of the shot furnace, there seems to be no reason why hollow shot should not be heated red-hot, as well as solid shot. However, as the larger calibres throw shells with advantage, it is less important to fire red-hot shot from them.

Solid shot.

Solid shot would naturally be fired from all long guns. In situations where the enemy's vessels would probably remain under fire till they could be heated, provision should of course be made for that purpose, and red-hot shot should be fired, taking care to regulate the charge, so that the shot might not pass through both sides of the vessel, but stick in her timbers.

Spherical case.

All sea batteries should be provided with a certain number of rounds of spherical case to fire against troops attempting to disembark, or at boats. Batteries to which ships can approach within musketry range, especially such as have not considerable command over the surface of the sea, should be supplied with grape and case to clear the tops, &c. of small arm men. There may be situations in which the larger descriptions of Congreve rockets may be fired with advantage against shipping. Fired horizontally from tubes at a short range, they could scarcely miss a large vessel. Round carcasses have some advantages over shell and hot shot, not requiring any particular length of fuze, not bursting prematurely in flight, and requiring no previous heating like hot shot.

Grape and common case.

Rockets and carcasses.

It has been ascertained they will bear the large charge required for horizontal firing, and as they burn for several minutes with a flame, very difficult to be extinguished, it is to be presumed they would be effective against ships of war. They can be fired as quickly as cold shot.

Mode of firing.

As the ordnance on sea batteries is frequently required to be directed against moving objects, it is essential that they should not miss or hang

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fire; and hence, the quickest and most certain mode of firing at the moment the object is in line should be adopted. It is conceived the rectangular percussion tube, fired by a hammer and lanyard, present the best means for attaining these objects, and should therefore be provided for all sea batteries.

Magazines. When magazines, containing large quantities of powder or ammunition, are situated near the batteries, as will sometimes occur, it is especially necessary to see that every possible means be taken to guard them from explosion by the enemy's fire. Where they are of old construction, it should be remembered how greatly the powers of artillery have been increased in latter years, and precautions formerly deemed sufficient, may be so no longer.

Expense magazines. One should be provided for every three or four heavy pieces. They are sometimes made in a traverse on the *terrepleine* of the battery. This arrangement of having the expense magazines in the battery between two guns, does not appear so advisable as forming them under the mass of the rampart, with an entrance from the rear, when localities permit.

Concluding remarks. It may be objected that much more elaborate means have been recommended for the armament and service of sea defences than were formerly deemed sufficient. It is to be borne in mind that naval gunnery in all its branches has made great progress since the last general war; that ships are built heavier and stronger than formerly; that they carry heavier metal; that they are now prepared to make extensive use of shells; that the application of steam to navigation affords great facilities for transferring a naval force from point to point, and for bringing ships of war in and out of action, without reference to the state of the wind; that lastly, a very general confidence prevails among naval officers, of the ability of a fleet to silence batteries, however formidable. For these reasons it seems incumbent on the artillery to leave no means untried by which the efficiency of sea batteries can be augmented, that whatever may be the result of future contests, they may feel they have neglected none of the resources at their command.

(Signed) E. N. Wilford,
Captain R.A.

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31*st January*, 1846.

Col. TURNER, C.B. in the Chair.

No. 5.—A letter from Captain W. M. Smith, late of the Royal Artillery, enclosing a report on the eastern coasts and harbours of New Zealand, made by him in 1842.

No. 6.—A paper from Captain W. B. Gardner, R.A., on laying morars.

The author in this paper proposes the use of a telescope to be attached to a portable stand, similar to that of a theodolite, the telescope to rest in Y's, be capable of removal, and have a small range of vertical motion; the pillar upon which the Y's are placed to have a vertical sliding motion in the tripod.

The line of fire to be obtained by placing the instrument on the *banquette*, bringing the wires of the telescope in line with the object, lowering it out of the line of fire, by means of the sliding motion of the pillar, reversing the telescope in the Y's, and depressing it sufficiently to enable a guiding line or directing bar to be placed on the platform of the mortar.

This is proposed to be used when great accuracy is required, as in experiments, &c., to avoid any error that might be occasioned by the difficulty of fixing the pickets accurately, or from the unsteadiness of the plummet in windy weather.

The paper also proposes, that to facilitate traversing, running up, &c., small trucks might be fitted to the mortar bed, and the truck lever applied on the principle of the carriages at present used on the dwarf traversing platform.

28th February, 1846.

Lieut.-Colonel A. F. CRAWFORD, R.A., in the Chair.

No. 7.—***Memoranda relative to the Winds, Times of Tide, &c., favourable to an enemy attempting a landing on the Island of Guernsey.***

Winds from the N.E., the E., or S.E. would favour an armament sailing from Havre de Grace or Cherbourg; a stiff breeze would bring them from the former in two tides, from the latter in one. From Cherbourg they would sail at or about high water, and ships would be in sight for four hours, boats for three in clear weather, reaching their destinations at low water or.

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half flood. With the above winds they would attempt a landing on the easternmost or northernmost part of the island, most likely at Lancresse Bay, Grand Havre, Vazon or Perelle Bays. If the weather were moderate they might anchor on the eastern coast in the Grand Roads, or to the S.E. of Castle Cornet upon the bank which runs nearly from Cape Breton to St Martin's Point in from 4 to 7 fathoms water, and a tolerably good anchorage, especially with a wind from the N.E. or N.W., and thence could land in their boats at any time of tide (most easily at low water or half tide), and at any part from St Martin's Point to Belgrave or Sampson's Harbour. Vessels coming through the Race of Alderney would appear from Fort George, &c. in the E.N.E. or thereabouts.

Winds from the E., the S.E., or S.S.W. would be favourable for armaments coming from Granville or St Malo; they would sail about high water, and would require about three tides to reach the island, appearing from Jerbourg in the S. or S.W. quarter.

In bad weather they would have to go round to the north-west coast, and anchor in some of the bays above-mentioned from Rocquaine to Lancresse Bays, if very moderate weather, they might land on the southern or eastern coast, most probably at Petit Bot or Fermain Bays. They might also anchor and land as above in the Grand Roads, or on the bank near Castle Cornet.

Winds from the S.S.E. to W. would be favourable for armaments coming from Brest and Morlaix; they would require from Brest nearly two days, appearing from Pleinmont in the S.W. or W. part of the horizon. The above winds are very prevalent in winter, and generally fresh, and would prevent information or assistance arriving from England.

With winds from S.W. or W., if bad weather, they could not attempt to land on the north-west coast, but would have to go round to the eastern coast, and land at Fermain Bay, Belgrave, or Sampson's Harbour.

The eastern coast appears to be the most exposed to attack, especially with ships of war, which could anchor in the Grand Roads or on the Bank should it not blow hard; a strong breeze from the S.E., S., or S.W. alone would prevent their remaining at anchor.

A landing might be effected at or near Vale Castle with a wind from the N., N.W., W., and S.W.

In the neighbourhood of Hoummette, at Perelle or Vazon Bays, or Grand Havre, with a wind from E.S.E., S., and S.S.W. It would be dangerous to land with a wind from the S.W., W., or N.W., and would seldom be practicable in winter. At Rocquaine Bay a landing might be effected from boats with a wind from N.E., E., S.E., and S., but a westerly wind would render it impracticable. At Icart a wind from N.E., N., N.W. and W.,

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would be favourable, and the best times of tide for these places are from half ebb during low water until half flood, and at other times of tides, and and with other winds especially, if strong, a landing would be dangerous, if not impracticable, especially in winter.

A landing on the southern coast would be almost impracticable in winter on account of the serf, except with the wind from N.W., N., or N.E., which seldom occurs at that season, and the bays are so small that they might be easily missed, especially at night.

A night attack upon this island would always be attended with danger on account of the strong tides and numerous rocks. Ships could not come near the land at night, and would be seen from some of the outposts during the preceding day, and preparation could then be made. In fine weather it might be attempted in boats from Cherbourg or Granville, in which case Belgrave or Fermain Bays would most likely be selected, or Lancresse Bay and Vale Castle; Rocquain and Vazon Bays would be dangerous places on account of the rocks.

The winds which would favour a descent in boats upon the coast from Fermain Bay to Lancresse Bay and Grand Havre are from the N.E. to S.E., and moderate or nearly calm, and pilots would be necessary. Winds from the S.W., W., N.W. and N., would prevent their coming.

NOTE.—This paper has been inserted in the hope that it might call the attention of officers stationed on the coast of England or Ireland to the practicability of an enemy effecting a landing in the vicinity of their posts, and induce them to make a reconnoissance of the coast, especially bays, rivers, &c., and other places favourable for such an undertaking in their immediate neighbourhood, ascertaining the points commanding landing places and the best positions whence the enemy's boats employed in landing the troops, or the troops themselves while forming on the beach and advancing to the attack, would be most exposed to the fire of guns or rockets, taking care that there is nothing in their rear to prevent their being limbered up and removed.

The points of land whence a fleet would first become visible should be ascertained, and signals established. For this purpose, artillerymen should be taught to keep a good look-out, and to use a telescope.

No. 8.—*Experiments on the Fire of Infantry.*

The following Experiments were made in the year 1839, by order of Lord Vivian, Master-General of the Ordnance, to ascertain the relative precision of the fire of the front and rear ranks.

Fifty gunners, with percussion muskets and in heavy marching order, two deep, occupying a front of 43 feet 9 inches, were formed up at the distance of 80 yards in front of a target 42 feet in length by 6 feet in height.

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It appeared from the trials that the practice of the front rank was better than that of the rear rank, in the proportions of 1 in 1·37 to 1 in 1·4 (hits to shots). That the two ranks firing together produce a better effect than the sum of the above, in the proportions of 1 in 1·36 to 1 in 1·39. That the front rank only firing, rear rank loading and handing their muskets to the front, is worse than both ranks firing. And that both ranks firing, the front rank kneeling is better than common file firing, in the proportion of 8 in 10 to 7⅞ in 10; but it must be observed in this trial, that the awkward position of the front rank while loading takes somewhat from their quickness in firing, compared with the best entry in the Table, giving a proportion of 8¾ to 10⅛.

Trials were also made with three deep, but the rear rank seldom hit the target in consequence of the knapsack of the front rank, and their fire rendered the front rank unsteady.

25 Files, Percussion Cap Muskets; File firing for 5 minutes. Target or Screen 42 feet by 6 feet; Range 80 yards.

	1st Trial.		2nd Trial.		3rd Trial.	
	Number of Balls Fired.	Hits.	Number of Balls Fired.	Hits.	Number of Balls Fired.	Hits.
1. Front Rank, Ball; Rear Rank, Blank	245	179	251	186	260	184
2. Rear Rank, Ball; Front Rank, Blank	208	139	239	151	249	202
3. Both Ranks, Ball	436	316	508	343	439	356
4. Front Rank only Firing; Rear Rank loading and handing the Muskets	421	296	439	314	...	...
5. Both Ranks firing Ball, Front Rank kneeling	424	326	438	381	...	...

No. 9.—*Remarks on Windage.*

By Captain Barker, R.A.

The subject of windage has long occupied the attention of artillerists, and the following pages show some of the proposals which have at different times been made, and the alterations which have consequently taken place, or the objections which have been urged against a change.

Sir Howard Douglas, in 1817, made proposals to the Select Committee of the Royal Artillery to diminish the windage of all ordnance, and in support of his arguments offered the following observations on the subject:—

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That it was found from Dr Hutton's experiments, that with the windage at that time allowed, viz. $\frac{1}{20}$ the diameter of the shot, from $\frac{1}{4}$ to $\frac{1}{3}$ of the force of the powder was lost, which loss being occasioned by the escape of the gas through the space between the shot and the side of the bore, will evidently increase in proportion with the squares of the diameter of the shot, and the calibre of the gun, consequently much would be saved by a reduction in the windage.

The following is a French Table, showing the proportional loss of velocity by an increase of windage.

French 8-pounders; windage varying from 0 to 2½ lines.

Windage.	Velocity.
0	1680 feet.
1	1442 „
2	1230 „
2½	1134 „

This was a serious waste of means, but the loss of accuracy was perhaps a still greater evil, caused not only by the diminished initial velocity as shown above, which must materially affect the precision of firing, but principally by the reflections of the shot along the bore of the gun, which thus acquires a zigzag motion, and whence arises either lateral deviation or an increased or diminished range, according to the part of the bore upon which the shot last impinges before quitting the cylinder, besides which the shot acquires an irregular whirling motion, causing great inequality of resistance, unless the rotation happens to be at right angles to the direction of the projectile's flight; and it is evident that these reflections of the shot will increase, in proportion with the difference between the diameters of the bore and shot.

With two shot still greater inaccuracy is caused, one receiving an impulsion from the other, and which will evidently be in an oblique direction, disturbing also by reaction the direction of the other; this practice with two shot was formerly considered of the greatest importance in naval actions, and consequently called for an alteration in the windage, which effected so materially the accuracy in firing. Sir Howard Douglas, in his work on "Naval Gunnery," in order to show the advantage of high shot, mentions a note of Sir Alexander Dickson's during one of the Peninsular campaigns:—

"The battering train was assembled at Almeida previous to the siege of Ciudad Rodrigo, and there being a great deficiency of transport to bring forward the shot from the rear, it became a very important object to collect as many as possible from the shot belonging to the fortress, of which there was a considerable quantity, and of an infinity of calibres; in order, therefore, to obtain every shot that would answer, gauges of the full diameter of our 24-pounder bore were used, and every shot was

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selected as serviceable that passed through these gauges, so that many of the highest balls chosen would not, when heated, go into the gun, and this I ascertained by trial; when this operation had been completed, the selected shot were again tried with a gauge rather smaller than the ordinary 24-pounder shot gauge, and all that went through it were rejected as too small. The number of very high shot, however, amounted to two or three thousand; and as I know they were brought forward in the latter part of the siege, it has always been to the use of these shot that I have attributed the singular correctness of the fire in making the smaller breach, for although the battery was from 500 to 600 yards distant from its object, every shot seemed to tell upon the same part of the wall as the preceding one. Now this was not the case in firing with common shot at such a distance, for some struck the wall high, and others low, although the pointing, as the best gunners have assured me, was carefully the same."

Formerly, when the method of casting shot and guns was but little understood, the former not being spherical, and the bores of the latter at one time cast upon a core not cylindrical, a much larger allowance of windage was necessary than at present, when the manufacture of both is so much improved, and the proofs to which they are subjected so rigid; but it is still necessary to make some allowance for error in casting shot and shell, as well as in the boring of guns; the limitations in the size of projectiles are from ·03 to ·015 inch above or below mean gauge, and in the diameter of bore from ·02 inch over to ·015 inch under; and as both errors may occur in the same direction, that is, the shot may be above the mean gauge, and the bore at the same time below the true diameter, this must be borne in mind in the consideration of windage.

Sir Howard Douglas pointed out the different circumstances which should be taken into consideration in apportioning the degree of windage to ordnance.

1st. The expansion of shot by heat.

2nd. The incrustation of a little rust, or a coating of paint to prevent corrosion and consequent increase of windage.

3rd. The foulness of cylinder from continued firing.

4th. The thickness of the tin straps which secure the wooden bottoms to the shot.

With respect to the first, the degree of expansion of shot when raised to a white heat, according to the French table, is

For a 24-pounder about $\frac{1}{70}$ of the diameter.

„ 16 „ $\frac{1}{76}$ „

„ 6 „ $\frac{1}{82}$ „

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Thus for the largest shot it would not amount to $\frac{1}{3}$ of the windage in existence in 1817, a much larger allowance than can be necessary. The following rule for windage has been applied, I believe, in the construction of some of the naval guns recently introduced into the service, viz. the difference in the diameter of the shot when cold and when raised to a white heat, added to one half of this difference, and which I should think would be a sufficient allowance for any contingency.

With regard to the second point, the incrustation of rust raised upon the surface by the oxidation of the metal can never be so great, if any care be taken of the shot, as to require a greater degree of windage than ·15, although there is an instance on record of a brig of war being armed entirely with carronades upon coming into action with the enemy, the greater part of the shot were found to be in such a state of rust, increased by the action of the salt water, that few could be got into the guns; she was consequently obliged to haul off for an hour to clean and scrape her shot, when she again returned to the engagement. Supposing her carronnades to have been 32, 42, or 68-pounders, the windage of these at that time was respectively ·94, ·1, and ·15 inch, either of which is an immense increase to be caused by rust if the slightest precautions be taken, and it cannot be necessary to make sufficient allowance for such a contingency, now that so much care is taken in painting and greasing shot, and keeping them free from rust. No coating of rust is likely to, or indeed should ever, exceed ·075 inch, and consequently with that increase, which is great, ·15 inch windage will amply provide for it; on board ship there should always be a certain number of shot kept gauged, ready for service, and any rust which may be found should be removed by rubbing instead of the violent hammering sometimes adopted, but the removal of the rust does not so much diminish the original size of the shot as is supposed, as the oxide of iron contains but a very small quantity in bulk of the metal.

The foulness of the cylinder, arising from continued and rapid firing, may be estimated as never exceeding ·06 or ·07 inch, and is to a very great extent prevented by the sponging between each round, but a hard crust is sometimes formed, particularly in dry weather, and causes great inconvenience, especially in musket barrels, but is not of so much importance in ordnance.

The tin straps which secure the wooden bottoms to the shot occupy about ·04 or ·05 inch in the bore.

The French allowance for windage, reduced to English measure, was, in 1817, ·133 inch for siege ordnance, and ·088 inch for field ordnance, being not much more than $\frac{1}{3}$ of ours. The calibre of a French 24-pounder

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was 5 inches, 7 lines, 7½ points, 1 line 6 points being allowed for windage, or 18 points in all, is about $\frac{1}{45}$ the calibre of the gun. The calibre of a French 8-pounder was 3 inches, 11 lines, or 47 lines, 1 line being allowed for windage was $\frac{1}{47}$ of the calibre. Sir Howard Douglas proposed the following scale of proportions:—

Nature of ordnance.	Calibre of gun.	Windage, $\frac{1}{10}$ calibre.	Diameter of shot, $\frac{9}{10}$ calibre.	Windage, $\frac{1}{70}$ calibre.	Diameter of shot, $\frac{69}{70}$ calibre.	Present windage, 1817, $\frac{1}{70}$ diameter of shot.
42	7·018	·2	6·818	·175	6·843	·33
32	6·41	·183	6·227	·16	6·250	·30
24	5·823	·166	5·657	·145	5·678	·27
18	5·292	·151	5·141	·132	5·16	·25
12	4·623	·132	4·491	·115	4·508	·22
9	4·200	·12	4·08	·105	4·095	·20
6	3·668	·105	3·563	·092	3·576	·17
4	3·204	·092	3·112	·08	3·124	·15
3	3·013	·086	2·927	·075	2·938	·14
1	2·019	·058	1·961	·05	1·969	·09

But he observed, "why should the windage necessary to permit shot to enter freely under the various circumstances of heat, rust, foulness of cylinder, or with tin straps, vary with different cylinders, as these circumstances bear no relation to the magnitude of the cylinder or ball, except the expansion of the latter by heat, which is so small even in the largest natures as not to exceed $\frac{1}{70}$ of the diameter, or about ½ the proportions of windage in the above scale?" He then proposed that for the 12-pounder and upwards ·13 inch should be allowed, and ·1 inch for the 9-pounder and smaller natures. It is, however, the opinion of La Martillière and some other continental artillerists, that the windage should vary with the calibre.

There was formerly a curious difference between the shells of carronades and those of guns; the latter being the same size as the shot, and the former ·1 inch smaller; the only reason to be assigned for this is the fear of the increased force of the powder, consequent upon the reduced windage of carronades, bursting the shell in the bore; but the charge of carronades being so much smaller than that for guns, the danger of this would be avoided.

The above changes in the windage would, of course, admit of a reduction in the charge; as it was considered the same velocities would be produced with smaller charges, greater accuracy would be obtained, and, consequently, greater effect; indeed, a reduced charge is necessary with reduced windage, on account of the increased recoil, and the consequent shock given to the carriage. Before recommending Sir Howard Douglas'

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system for adoption, experiments were carried on to ascertain whether the shot would roll freely home, and also the advantages to be derived from this reduction. The first were with field guns, having a windage of ·075 inch, instead of the established quantity of $\frac{1}{24}$ the diameter of the shot; and to prevent the gun or carriage receiving injury, on account of so small a windage, a charge $\frac{1}{8}$ less than usual was substituted, conceiving that an equal, if not a greater range would be obtained; after repeated firings from a 6, 9, and 12-pounder, at different ranges, the result verified this conjecture; the larger shot and smaller windage giving rather the longer range. Recourse was also had to the ballistic pendulum to ascertain the proportional excess of momentum of the larger over the smaller ball, and the trials were in favour of the larger shot; but it was not considered prudent to reduce the windage beyond ·09 or ·1 inch for field guns, with the established charge, to avoid any difficulties which might arise from rust or strapping, &c.

Experiments were also carried on with a 24-pounder; the established windage of which was ·27 inch, at various ranges; and a reduction was consequently recommended to ·15 inch in iron ordnance, from 18-pounders and upwards, with the usual charges; but as this involved the question of guns on board ship, as well as on land service, it was referred to the Navy, who objected to the reduction, in consequence of the carronades, which were then much used on board ship, being of smaller calibre than the guns of the same natures, which would cause confusion; as the alterations must necessarily be made by casting new shot, and not new guns, and also because considerable inconvenience was found to attend small windage in naval guns; probably in consequence of the practice of double shotting their guns, which was of so much importance in naval actions, and with a reduced windage, would cause a still greater strain upon the carriage and breeching; besides shot being more liable to rust to any considerable extent on board ship than on land, from the action of the salt water; the instance, above-mentioned, of a brig-of-war armed entirely with carronades was brought forward in the argument.

The reduction recommended in windage was consequently limited to field guns; but even this was deferred, in consequence of the immense quantity of shot then in store.

About the year 1823 the windage of iron ordnance was slightly reduced; being made about $\frac{1}{27}$ of the calibre, instead of $\frac{1}{20}$ of the diameter of the shot; which was effected by doing away with the low gauge for the shot, and substituting one of what was then the medium diameter; thereby reducing the manufacturer to work within narrower limits. And in the new iron ordnance, both for land and sea service, which have been

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introduced within the last seven or eight years, the mean windage of the largest calibre, as of the 68-pounder of 113 cwt., does not exceed ·2 inch, or $\frac{1}{40}$ of the calibre, and of other natures in proportion. One great difficulty which has always existed in our service with regard to a reduction in the windage, is the great variety of calibres which exist in each nature of ordnance, particularly since the introduction of carronades with their small windage; that, in order to diminish the windage of the larger calibre in any one nature, as, for instance, a 32-pounder, with ·3 inch windage, it would have been necessary to have cast a shot which would not have entered the bore of a 32-pounder carronade, with only ·094 windage, and not freely into that of the smaller 32-pounder guns; thus inducing the necessity of having different diameters of shot for the same natures of ordnance; causing great confusion, which might be productive of most disastrous results. A still further simplification in the calibres and natures of ordnance might be of advantage to the service.

In 1843 the windage of field guns was reduced, as previously proposed, viz. to ·09 inch for the 3-pounder, and ·1 inch for the higher natures; with this windage some shot were sent to Ireland, to replace the old store of shot; but the vessel in which they were sent having sprung a leak, the wooden bottoms became so much swollen from immersion in the water, that the greater part would not enter the guns, and were consequently returned to Woolwich. The wooden bottoms are made ·1 inch smaller than the shot, and therefore ·2 smaller than the bore of the gun; and if there was much more difference between their diameter and the calibre, they would not answer the purpose for which they are intended; and the older and more seasoned the wood of which they are made, the more swollen they become from moisture.

The influence which the windage has in rendering the gun sooner unserviceable from continued firing is a consideration of the greatest importance; the injuries done to the bore by the reflections of the shot, when there is much difference between the diameter of the shot and the calibre of the gun, and which, of course, increase in proportion, with this difference, and eventually render the gun unserviceable, are principally about the seat of the shot; the centre of which, being below the axis of the piece, the elastic fluid has a tendency to force the shot downwards; and as the metal becomes heated from continued firing, the progress of these indentations is much accelerated, particularly in brass guns. On this account, therefore, after due consideration for the other points, the smaller the windage the better; but some continental artillerists have contended that a small windage very much assists in speedily rendering the guns unserviceable. Now there are two ways in which the explosion

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of the charge will effect this; 1st, the mechanical action of the gas, which, as has been stated above, and which, I think, it is evident, will increase in violence with the degree of windage; 2ndly, the chemical action of the gas upon the metal of the gun, which, not being able to escape through the windage ring, and, consequently, being more confined, acts with greater effect upon the gun, accelerating the enlargement of the vent, and, in brass guns particularly, softening the metal, rendering it more capable of receiving injury from the shot, and, to some extent, decomposing the gun metal, separating the tin from the copper; and these causes increase with the calibre, and consequently increased charge of the gun. A very good proof, however, of the advantage of small windage in this respect occurred in 1845, and it is well worthy of notice: a light 9-pounder of 10½ cwt., charge 2 lbs. 2 oz., with only ·09 windage, was fired 400 rounds; at the end of which the vent was found to be still uninjured, and the indentations in the bore barely perceptible by Desagulier's instruments; which, in the old guns, with ·2 inch windage, were sometimes perceptible after 20 or 30 rounds.

I have heard it stated that, during the experiments in 1843, the following curious fact was observed, viz. that by reducing the windage beyond a certain point, the range was proportionably diminished; it was accounted for by the rapid condensation of the column of air in the cylinder in front of the shot causing greater resistance from not having the means of escaping behind the shot as it passes through the bore. In opposition to this, however, there is an experiment on record of a gun without any windage making good practice. This gun was invented by a Swede, and was made to load at the breech; the chamber being rather larger than the bore of the gun, the shot was coated with lead, and which was torn off in its passage through the bore: the recoil of this gun was also completely checked; but, however absurd it may appear to suppose that a reduction of windage beyond a certain point has any effect in diminishing the range of the projectile, it may not be altogether amiss to consider, in any future alterations that may take place, whether the windage should not to some extent be regulated by the length of the cylinder.

Another very essential point to be considered in apportioning windage, is the greatly increased recoil, and consequent shock to the carriage, caused by a reduction in the windage. The ranges of two guns of different weights, but throwing the same weight of shot, being equal at any one angle of elevation, it is evident that the initial velocities of their shot must be equal, and, consequently, the momentum of the recoil of the two guns on their carriages also equal; the momentum of the gun and shot being equal in opposite directions. The velocity of the recoil,

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therefore, of the lighter gun (*i. e.* the momentum divided by the weight of the gun), must be greater than that of the heavier gun, and it is this violent action which strains the carriage, and which must always take effect somewhere, although, by the position of the trunnions, mode of mounting, &c., the direction may be altered, and made to act more or less horizontally or perpendicularly; and the same, of course, occurs with guns of equal weight, throwing the same weight of shot with equal charges, but of which the range of one is superior to that of the other, from its having a smaller allowance of windage; rendering the momentum of its recoil and strain upon its carriage also greater. In 1843 experiments were carried on with a light 9-pounder, of 10½ cwt., proposed to be used by the Horse Artillery for general purposes instead of the light 6-pounder (but still retaining this gun for light divisions, outposts, &c.) This gun was tried against the old medium 9-pounder, of 13½ cwt., of which the windage up to that period had been ·2, but which was then reduced, as had been some years previously recommended, to ·1. During the experiments, however, various charges and windages were tried; the lowest being, charge 2 lbs. 8 oz., windage ·09 inch. The charge of the light 9-pounder was 2 lbs. 2 oz., and windage ·09. After very severe trials, the result, with respect to range, was, if anything, in favour of the heavier gun, as, likewise, the recoil; the light gun recoiling about 2 feet more than the old medium gun, and its trail jumping rather more, sometimes 4 or 5 inches; although both of these, the recoil and the jump, were less than those of the light 6-pounder; and the only part of the carriage which gave way was the flange, through which the elevating screw works, but which is easily remedied, and not of unfrequent occurrence with other guns. But the velocity of the recoil of this gun must necessarily have been much greater than that of the other, more than 3 cwt. heavier; the ranges and initial velocities of their shot being equal. This gun proved, however, that by diminishing the windage as far as possible, consistently with the safety of the gun and carriage, a great advantage is obtained; and in 1845, especially as has been above stated, its advantage in preserving the bore and vent from injury during rapid and continued firing; and it also shows that a reduction in the metal of guns might be made, for which purpose further experimental trials might be of the greatest service. The great principle of field artillery being to obtain sufficient range and velocity, with the least possible expenditure and the greatest celerity of movement.

In consequence of the above experiments, the charge of the service 9-pounder medium gun, of 13½ cwt., was reduced half a pound, viz. from 3 lbs. to 2 lbs. 8 oz., with ·1 windage.

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The following Table shows the dimensions of the shot and shell now in the service, and the windage allowed to the different natures of ordnance :—

		Mean diameter.	Founder's limits over or under.	Mean windage.	Diameter of bore.
Shot and Shell.	10-inch shell gun	9·85	·025	·15	10
	8-inch ditto	7·925	·025	·125	8·05
	68-pounder, of 113 cwt.	7·925	·025	·195	8·12
	56-pounder	7·48	·03	·175	7·65
	42-pounder	6·762	·025	·208	6·97
	32-pounder, 56 cwt.	6·177	·03	·233	6·41
	" A. gun	...	...	·198	6·375
	" B. and C. guns	...	...	·173	6·35
	32-pounders, bored up from 24-pounders*	...	...	·173	6·35
	32-pounders, bored up from 18-pounders	...	...	·123	6·3
Shot only.	24-pounder, 50 cwt.	5·6115	·027	·211	5·823
	24-pounders, bored up from 18-pounders	...	...	·138	5·75
Shell only.	24-pounder	5·598	·025	·288	5·823
Shot and Shell.	18-pounder	5·099	·025	·193	5·292
	18-pounders, bored up from 12 and 9-pounders	...	...	·071	5·17
	12-pounder	4·523	·02	·1	4·623
	9-pounder	4·1	·02	·1	4·2
	6-pounder	3·568	·018	·1	3·668
	3-pounder	2·823	·015	·09	2·913
Carronades.	Shot and Shell. 68-pounder	...	...	·125	8·05
	Shot and Shell. 42-pounder	...	...	·078	6·84
	Shot and Shell. 32-pounder	...	...	·073	6·25
	Shot only. 24-pounder	...	...	·0685	5·68
	Shell only. 24-pounder	...	...	·085	...
	Shot and Shell. 18-pounder	...	...	·061	5·16
	Shot and Shell. 12-pounder	...	...	·066	4·52
	Shot and Shell. 9-pounder	...	...	·06	4·14
	Shot and Shell. 6-pounder	...	...	·05	3·6
Mortars and Howitzers (Shells only).	13-inch	12·84	·04	·16	13
	10-inch	9·84	·04	·16	10
	8-inch	7·86	·04	·14	8
	5½-inch	5·595	·025	·025	5·62
	4⅕-inch	4·454	·022	·066	4·52
	24-pounder	5·595	·025	·125	5·72
	12-pounder	4·454	·022	·122	4·58

Variation allowed in the diameter of the bore of all ordnance is ·02 over and ·015 under.

* The 32-pounder of 32 cwt. and 6 ft. 6 in., bored up from Sir T. Blomefield's 24-pounder, has only ·123 windage.

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31st March, 1846.

Col. J. E. Jones, Assistant-Adjutant-General, in the Chair.

No. 10.—*On Coast Defences.*

By Capt. A. J. Wilson, R.A.

Although the brilliant achievements of our navy at Algiers and Acre, and yet more recently on the River Plate, have given rise to an opinion that land works are unable to cope with ships of war, even for a few hours, yet the success of our fleets may be due rather to the skill and gallantry of our sailors, than to the necessary superiority of ships of war over land works.

It is the object of the writer, first, to show the necessity of Great Britain being provided with coast defences, and next, to point out what the general construction of such works should be, and that they are not necessarily unequal to cope with shipping. It is evident that in this inquiry, we must altogether rely on the experience of former wars; the introduction of steam into the navies of Europe and America has materially altered our position, by its having greatly lessened the power of our navy to shield us from sudden, though brief attacks of the enemy on our coasts. Before the use of steam vessels, the blockade of an enemy's port was much facilitated by the certainty that when the wind blew in particular directions he could not issue forth; and even if he made his escape, he would require to be singularly favoured to be able to shape his course so as to arrive on our coasts, bombard a British port, and return again with impunity. But the introduction of steam into the navy, "a changé tout cela;" for, supposing a blockade might be still maintained as successfully as before (which we doubt), it is evident that any enemy's steamer once at sea might run over to any of our undefended coast towns, do infinite damage in a very short time, and depart before she might be overtaken by our cruisers. If this statement be correct, our coasts cannot be guarded by our navy alone; there must be a combined defence. There must be land works.

Before we proceed to consider which is the best position and construction of such works, let us endeavour to ascertain the duties they will be required to perform.

As long as we maintain our superiority at sea, no enemy's fleet will be

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permitted to remain with impunity on our coasts any longer than the time required for our fleet to meet them; and this period will be very short from the rapidity with which intelligence can now be communicated. We should also be enabled, by means of our numerous railroads, to accumulate with great celerity a large body of troops on any threatened point.

Under these circumstances, an enemy may either attempt to invade us, for the purpose of conquest, or he may endeavour to harass us, by landing troops for the purpose of destruction, or by merely bombarding us from his ships.

But an invading army, not being able to rely on its fleet as a base of operations, since that fleet would be momentarily exposed to be driven from our coasts, would not fritter away its time on our coast defences, but either neglect them altogether, or, having masked them, proceed to make itself master of some large town to supply the place of its fleet, as a *point d'appui*.

Should the enemy land merely for the purpose of ravaging our territory, he must bear in view his re-embarkation; and not being able to calculate on his fleet being allowed to await for any considerable period his return on board, his operations must be rapid, and his descent short.

Hence, whatever may be the nature of an enemy's operations on our coasts, our coast defences will not be required to resist a lengthened land attack.

This being the case, our coast works should be more offensive than defensive; they should be so constructed as to maintain a powerful fire on the enemy's ships, be as little as possible exposed to his fire, and be proof against a *coup de main*.

In order to obtain these advantages, whether should we employ casemated works or field works?

In casemated works, the cheeks of the embrasure being upright, and it being arched over at the top, an enemy's shot once entering must pass through, either in a direct course, or, what is much more destructive, by bounding and rebounding from side to side, from top to bottom, increasing at every stroke the number of splinters which it carries along with it, from the stone of which the casemate is formed; and, although the chance of a shell entering is lessened by the newly-adopted plan of causing the traversing carriage to revolve close to the parapet, yet, if a shell does enter, its effect will be increased. What masonry would resist the explosion of a concussion shell in a casemated embrasure?

The lateral range of guns through a casemated embrasure being limited, an enemy may place his vessel in such a position as to be out of the range

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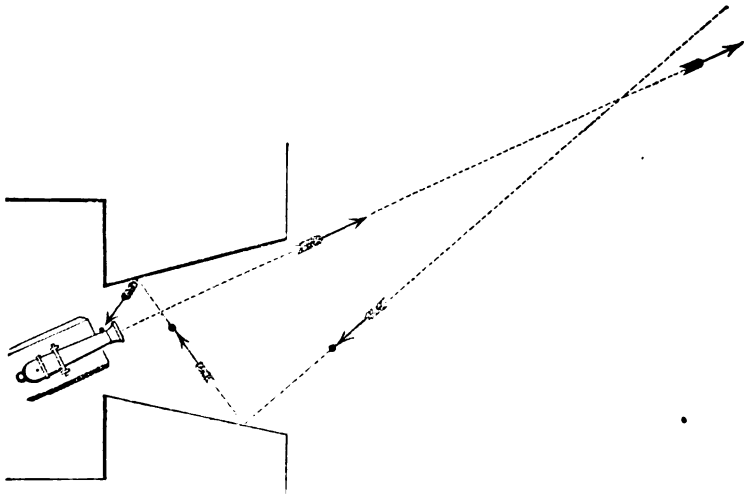
of the fire from the casemate, and yet be able to fire into it in an oblique direction, thus



So that, commencing with a flank embrasure, all the guns in the casemate may be silenced in detail, unless that casemate be flanked by some other work.

Casemated batteries are of two kinds; the arches being in the one case perpendicular to the line of the work, and in the other parallel to it; in the former, which the French call *en décharge*, each gun is placed under a separate arch, opening to the rear towards the *terreplein* of the work; this construction permits the smoke to escape more easily than the latter method; but the isolation of the guns renders their general superintendence more difficult. In the second method, where a long arch runs parallel to the line of the work, after a few rounds, the casemates become untenable from the smoke.

Casemates *en décharge* are equally exposed in their rear, with any battery behind a common parapet; and if guns be placed on a platform above the casemate (as at the Blockhouse, Gosport, which is considered as one of the best construction), they can only be supplied with ammunition, casualties replaced, or wounded removed, by means of steep and inconvenient staircases.

Should a casemated tower be adopted, the confined interior space into which the revetments *en décharge* open, very much impedes the escape of the smoke, and its guns may be silenced one by one, by a method too long to describe in this paper, but which is fully detailed in Lamillard Fallot, Vol. II. p. 193. In support of these statements, the following authorities are referred to.

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Dufour, p. 42 :—"Les pièces renfermées dans ces casemates ne peuvent tirer que par des embrasures étroites, ou en champ trèslimité, et l'ennemi peut facilement en éluder les coups, celui-ci prenant alors pour point de mire ses embrasures, véritables entonnoirs, dirige à la fois sur chacune d'elles tout ce qu'il a d'artillerie, et au bout de quelque temps elles se trouvent encombrées de débris; les boulets qui pénétrent dans l'intérieur viennent frapper les murailles, les ébranlent, et de leurs éclats estropient les canonniers, l'explosion des bouches à feu concourt avec les coups de l'ennemi à tout démanteler et à rendre très-promptement les casemates parfaitement inutiles a l'assiégé. Ces grands inconvénients ne sauroient être révoqués en doute, ils sont constatés par l'expérience, et il est reconnu qu'il n'existe à peu près aucun moyen d'y porter remède."

St Marie, p. 163 :—"Il existe en France, et dans plusieurs contrées méridionales, un grand nombre de batteries de côte entièrement en maçonnerie, c'est un grand vice de construction parcequ'un seul boulet qui frappe le parapet chasse une grande quantité de pierres dans le terre-plein et fait autant de mal que plusieurs boulets à la fois."

It is to be regretted that we need not go to France to see stone parapets.

Dufour, Permanent Fortification, p. 42 :—"Les casemates dont le moindre inconvénient est l'énorme dépense qu'elles exigent sont intenables après quelques salves, du moins celles qui sont fermées à leurs parties postérieures l'épaisse fumée qui s'y accumule empêche de distinguer les objets extérieures, et finit par rendre l'air tout-à-fait irrespirable."

Jones's Sieges, Vol. II., note 42, on the Capture of Scylla :—"On examining the interior of these casemates, before steps could be taken to clear or purify the castle, it was altogether surprising to observe the mischief which had been produced by the shots which had deflected from the cheeks of the embrasures, and entered the casemates. To judge from the indentations on the walls, and the marks of slaughter and destruction which everywhere presented themselves, a direct fire into a casemate embrasure of the usual construction must render casemate batteries untenable; indeed, in the attack, the French loss was chiefly by shot which entered the embrasures, and passed through the rear of the casemates."

Why then does it happen that, in opposition to such high authorities, casemated coast batteries are still so generally employed by us? General Pasley furnishes an answer in his Elementary Fortification, p. 470, where

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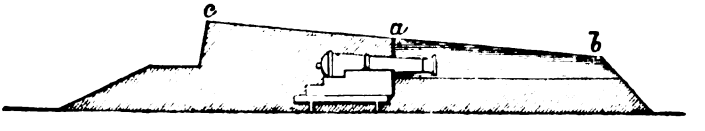
he writes thus:—"When a shore is low, and of such a nature that ships can approach within close musket-shot of any spot chosen for a defensive battery, it is *then* necessary that the interior of the battery should be covered at the top by a proper musket-proof defence; otherwise, marksmen placed in the ships' tops will be able to destroy the men in the battery by a plunging fire. A casemated battery open to the rear is therefore the best that can be used in such situations; but it is not absolutely necessary that the arches should be bomb-proof."

If these quotations be correct, it follows that casemates are far from securing their defenders from the effects of direct fire, and that their own fire is limited and impeded; to which disadvantages we must add the very great expense of their construction.

Their advantages consist in security from vertical fire, and being proof against assault, when they are constructed in the form of a tower.

Let us now consider field works.

The guns may be either mounted *en barbette,* in which case both the artillery, and a portion of the men, are much exposed to the enemy's fire, but by which a great lateral range is given to the guns; or the artillery may be better protected by being placed in embrasures, which, however, confine the lateral range. Field works are open to vertical fire, and more easily taken by assault than towers. They are, however, constructed at a much less expense than casemates. If therefore it be possible to construct them, so that the guns may obtain an extended lateral range, without being exposed to a harassing direct fire from the enemy, so as to be protected from the fire from his tops (see General Pasley), and to be able to defend themselves against a *coup de main,* field works will, in such cases, be not merely equal, but superior to casemates, for the purposes of coast defences. In order to obtain protection, combined with lateral fire, let the parapet be made sufficiently thick to admit of the platform of the gun being placed in it, and sufficiently high to shelter the men from the enfilade fire of the enemy; and let the embrasure slope off immediately on each side into the superior slope of the parapet, something in the manner of the accompanying rough sketches, which are not intended to give the proportions, but merely to explain this description.



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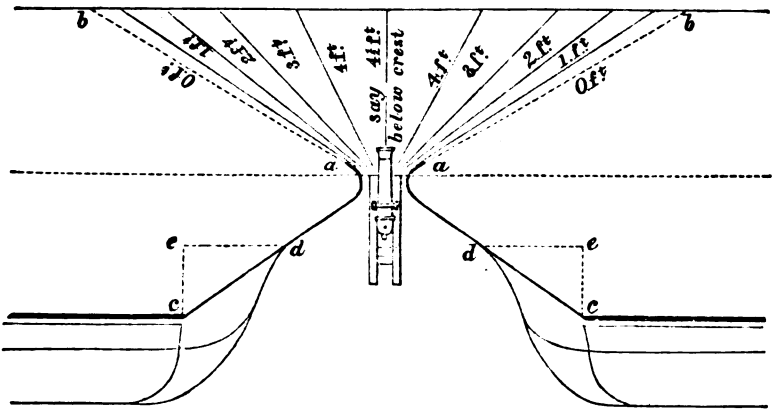
Exterior Crest.



The embrasure falling from *a* to *b* by a gentle slope, and not by an abrupt edge, into the superior slope of the parapet, the writer conceives that the points at *aa* will be rendered sufficiently strong, by the additional parapet from *a* to *c*, to allow of the space for the platform of the gun opening out to *cc*, without endangering the points *aa*, even although the embrasure be sloped off as described. The space for the platform of the gun should be as restricted as possible close to the genoulliere at *aa*, which is rendered more practicable by the traversing platforms being now made to revolve close to the genoulliere. If it be thought advisable to give better cover to the gunners, from shot entering in the direction *ba*, the parapet might be cut in the direction *dec*, leaving sufficient thickness to secure the point *a*.

Having thus endeavoured to procure a lateral range, together with a cover for the men and guns from direct fire, let us consider in what manner we may endeavour to defeat the vertical fire from the shipping.

In the passage quoted from General Pasley the reason stated for covering the guns with casemates is to obtain protection from the fire of the enemy's tops; this might be equally secured by retiring the battery a sufficient distance from the nearest point at which a ship can come to action, to be out of musket range of her tops, say 300 yards.

With regard to the vertical fire of shells, mortar practice from a ship can never be sufficiently exact to enable the enemy to throw his shells into a small space; it is, therefore, proposed to place very few guns, say three at most, in each work, but to place several of these works sufficiently

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near each other to concentrate their fire on one ship, and yet so far apart that the ship cannot diverge its fire on them.

This paper having already been extended too much, it is merely stated that the construction of each work should be made such as to secure it against a *coup de main* by every means known in field fortification. The writer's ideas on this subject will be pointed out in a future paper should this meet the approval of the R. A. Institution.

We have lastly to show that land works may advantageously cope with shipping:—

1st. Those proposed can concentrate their fire on an enemy's ship whilst she cannot separate her fire upon them.

2nd. The land works containing individually few guns, and having their slopes falling gently into the natural lie of the ground, offer small and ill-defined marks to the shipping; the sides of the enemy's vessels offer a fair object for our concussion shells, whilst that description of shell will only be destructive to our men and guns when they fall exactly upon them, since although the concussion of the ricochet on water be not sufficient to explode the shell, that on land is.

3rd. The enemy's vessels not being able to approach near to the battery, the angle of error of his fire, arising from the motion of the vessel, will exceed that of the battery on a steady platform, in proportion to the distance of the ship from the battery.

4th. As the batteries may be armed with ordnance of at least an equal calibre with that of the ships, the former will have the initiative of fire whilst the ships are coming into action.

5th. The enemy's ships cannot continue their fire when their troops are landing, as he would only have about half a degree of elevation to come and go upon, between either firing over our works or into his own men, too nice firing for the unsteady platform of a man-of-war, whilst his men would have to form on the beach and advance to the attack under the undisturbed fire from our batteries, and embarrassed by a ground rendered difficult by the obstacles placed in his way.

Lastly. Each battery should possess a chart of the river or sea within the range of its fire, so that the exact range of every spot should be known, as well as the course of the vessels, in approaching the batteries. Thus, provided the artillery of the coast defences be frequently practised with shot and shell, not a shot would be thrown away by the land works, whilst the enemy must learn their range by experience.

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The writer of this article is aware that a most able officer has stated his opinion that coast works should not consist of small batteries, which only tease an enemy's ship; but if the fire of these batteries be concentrated they will have the effect of a large one, whilst the enemy will not be able to charge rapidly past; and as our chief commercial towns, such as London, Liverpool, Glasgow, lie at some distance from the mouths of rivers, surely a series of such works as I have described are more likely to stop his progress than large works at their mouths.

As actions are better than words, let us look at the battery at Polder Dyke on the Scheldt, commanded by the gallant Captain John Parker, R.A., who was so well known to many of us, which work, though *showing no appearance of fortification beyond the barely visible site of two embrasures*, and armed only with an 18-pounder and a 5½ inch howitzer, the former of which could not be brought to bear on the enemy's ship, after an action which lasted from 7 in the morning till noon, beat back an 84-gun ship which had come from Antwerp expressly to drive the British from their post; with 41 men, including their commander, killed and wounded. The fort being uninjured, and only one man killed and two wounded.

The following words of Dufour may form a fit conclusion for this paper:—"C'est précisément ces raisons, jointes à beaucoup d'autres, qui me font croire que les avantages des batteries blindées ne compensent pas tous leurs inconvénients; et qui me font préférer la défense libre et découverte: on trouvera d'immenses avantages dans la liberté des mouvements, et dans la facilité de placer de l'artillerie partout ou il est nécessaire et de diriger des feux dans toutes les directions."

J. A. Wilson, *Captain R.A.*

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30th April, 1846.

Major ASKWITH in the Chair.

No. 11.—*Alteration in the Construction of Rockets.*

Description of an Alteration in the Construction of Rockets, prepared by the Director of the Royal Laboratory, by order of the Right Honourable Sir George Murray, G.C.B., &c. &c., Master-General of the Ordnance, June 1844, *by which Rockets may be used either as Shot or Shell Rocket, and the Shell be made to burst either at long or short Ranges, as may be required.*

Every rocket is fitted with a fuze, screwed into the base of the shell. The fuze is as long as the size of the shell will admit of, so as to leave sufficient space between the end of it and the inner surface of the shell for putting in the bursting powder; and the end of the fuze is cupped, to serve as a guide in the insertion of the boring bit. There is a hole in the end or apex of the shell, secured by a screw metal plug, for putting in the bursting powder, and for boring, according to the different ranges at which it may be required to burst the shell. The following Table shows the dimensions of such parts of the rocket as are affected in this alteration:—

Nature of rocket.	Distance from the surface of the shell to the end of the fuse, in inches and tenths.	Length of the fuse.	Distance from the surface of the shell to the top of the cone in the interior of the rocket, in inches and tenths.	Diameter of fuse composition, in tenths of an inch.	Diameter of fuse-hole, in tenths of an inch.	Diameter of plug-hole, in tenths of an inch.	Shell contains, of fine grain powder, in ounces.	Thickness of the rocket composition above the cone.
24-pounder	1·6	3·3	9·3	·25	·75	·4	8¼	3·3
12-pounder	1.	2·5	7·2	·25	·75	·4	3½	2.8
6-pounder	·9	2·	5·7	·2	·55	·25	1½	1·8
3-pounder	·7	1·3	4·	·2	·55	·25	¾	1·5

The following additions are to be made to rocket equipments:—

Bursting powder, fine grain, made up in bags, and marked according to the nature of the rocket.
Funnels for loading the shells.
Boring stocks or braces.

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Boring bits, of the same diameter as the fuze composition, fitted with brass graduated scales, and of a length sufficient to bore to within one inch and a half of the top of the cone in the 24-pounder rocket, and to within one inch of the top of the cone in the 12, 6, and 3-pounders.

Turnscrew bit for the plug.

Grease for the boring bits.

These additional particulars will be provided to all rocket equipments, packed in cases, according to the pattern fixed upon, and in the following proportion:—

To every Equipment not exceeding 144 *Rockets.*

Burster for each rocket	1
Funnels	2
Boring stock	1
Boring bits	2
Brass scales, fitted to bits	1
Turnscrew bits	2
Grease box	1

To every 12*-pounder Field Carriage.*

Bursters	100
Funnels	2
Boring stock	1
Boring bits	2
Brass scales, fixed to ditto	1
Turnscrew bits	2
Grease box	1

To every 6*-pounder Field Carriage.*

Bursters	216
Funnels	2
Boring stock	1
Boring bits	2
Brass scales for ditto	1
Turnscrew bits	2
Grease box	1

To every Horse or Mule-Load in 3*-pounder Mountain Equipments.*

Bursters corresponding to the number of rockets.	
Funnels	2
Boring stock	1
Boring bits	2
Brass scales for ditto	1
Turnscrew bits	2
Grease box	1

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In field service the bursters are to be carried in the limber boxes in canvas cartouches similar to those in which the field ammunition is carried; being, for the 12-pounder rocket carriage, 50 bursters in each limber box, diminishing the former number of rockets by four, to make room for them; and the small stores in a box on the body of a carriage opposite, and corresponding to the slow match box. For the 6-pounder carriage, 108 bursters, also in canvas cartouches, in each limber box, diminishing the number of rockets by eight, and the small stores in a box which is between the limber boxes. In mountain equipments the bursters and small stores in a box fitted to the pack-saddle. For Her Majesty's ships of war the bursters will be issued in numbers corresponding to the established number of rockets, in the metal-lined cases of the service, and the small stores in a box made for the purpose.

For garrisons, or other occasional demands, the bursters will be issued in such packing cases as are now in the service, and best suited to the number of rockets demanded, and the small stores in a box made for the purpose.

Some general Observations on firing Rockets under the altered circumstances.

If the rocket is to be used as a shot rocket, the only thing to be attended to is to take care that there is no powder in the shell, and that the plug is secured in the plug-hole.

If the rocket is to be used as a shell rocket, at the longest range, the plug is to be taken out and the shell filled, the fuze left at its full length, and the plug replaced.

If at the shortest range the fuze is to be entirely bored through, and the rocket composition bored into, to within one inch and a half of the top of the cone in the 24-pounder rocket, and to within one inch in the 12, 6, and 3-pounder rockets. The distances from the surface of the shell to the top of the cone, and from the surface of the shell to the end of the fuze, and also the length of the fuze being fixed and known, the place on the boring bit at which to screw the stopper, whether for various lengths of fuzes, or lengths of rocket composition to be left over the cone, is easily determined; these distances are marked on the brass scales for each nature of rocket, and the length of rocket composition available for boring into, and the lengths of fuze, are also set off and subdivided into tenths of an inch.

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General Observations on Elevations, Ranges, and Lengths of Fuze; but which have not been confirmed by any extensive course of practice.

24-pounders.—If the whole length of the fuze is left in the shell of the 24-pounder rocket, it may be expected to burst at about 3300 yards, elevation 47 degrees.

If the whole of the fuze composition be bored out, and the rocket composition left entire, the shell may be expected to burst at about 2000 yards, elevation 27 degrees.

If the rocket composition be bored into, to within 1·5 inch of the top of the cone, the shell may be expected to burst at about 700 yards, elevation 17 degrees.

12-pounders.—If the whole length of the fuze is left in the shell of the 12-pounder rocket, it may be expected to burst at about 3000 yards, elevation 40 degrees.

If the whole of the fuze composition be bored out, and the rocket composition left entire, the shell may be expected to burst at about 1500 yards, elevation 20 degrees.

If the rocket composition be bored into, to within one inch of the top of the cone, the shell may be expected to burst at about 420 yards, 10 degrees elevation.

6-pounders.—If the whole length of the fuze is left in the shell of the 6-pounder rocket, it may be expected to burst at about 2300 yards, elevation 37 degrees.

If the whole of the fuze composition be bored out, and the rocket composition be left entire, the shell may be expected to burst at about 1100 yards, elevation 15 degrees.

If the rocket composition be bored into, to within one inch of the top of the cone, the shell may be expected to burst at about 420 yards, elevation 10 degrees.

3-pounders.—If the whole length of the fuze is left in the shell of the 3-pounder rocket, it may be expected to burst at about 1800 yards, elevation 25 degrees.

If the whole of the fuze composition be bored out, and the rocket composition be left entire, the shell may be expected to burst at about 850 yards, elevation 12 degrees.

If the rocket composition be bored into, to within one inch of the top of the cone, the shell may be expected to burst at about 420 yards, elevation 8 degrees.

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On the use of Boring Bits and Scales.

The composition for the fuzes for the 24 and 12-pounder rockets being of the same diameter, one boring bit serves for these two natures, and the same is also the case with the 6 and 3 pounders. One brass scale also serves for the 24 and 12 pounders, and one for the 6 and 3 pounders, but the graduations for the different natures of fuzes and compositions are separately marked on each scale; which natures are also marked on each side of the scales; and the following description and method of application is to be attended to. Take, for instance, the side of the scale marked 24-pounder, the distance from the shoulder A at the end to the beginning of the second blank space (the point D in the drawing) is the length from the surface of the shell to the extremity of the fuze, therefore if the point of the boring bit be placed against the shoulder, and the edge of the stopper upon that point, and screwed fast upon the bit, and then if the shell is bored into up to the stopper, the whole of the fuze composition will be bored out; and if the stopper (the end of the bit being against the shoulder) be screwed on at any given mark on the scale, in that part of it marked for the fuze, the boring into the fuze with the stopper so fixed will leave a length of it, equal to the distance from the point D to the mark where the stopper is screwed on; also, the distance from the shoulder to the beginning of the third blank space (the point B in the drawing) is the length from the surface of the shell to that depth to which the greatest boring into the rocket composition may be made; therefore, if the point of the boring bit be placed against the shoulder and the edge of the stopper upon that point, and screwed fast upon the bit, then if the rocket is bored into up to the stopper, as much of the rocket composition will be bored out as it is safe to do. In like manner, the stopper being screwed on at any given mark on the scale, in that part of it marked for the composition, the boring into the rocket with the stopper so fixed will leave a length of composition above the cone over and above that length which always *must* be left, equal to the distance from the point B to the mark where the stopper is screwed on.—N.B. The boring bit should always be greased.

JAMES COCKBURN,
Director.

July, 1844.

Demands for Rockets had best be made by the gross, or by dozens, on account of convenience of packing.

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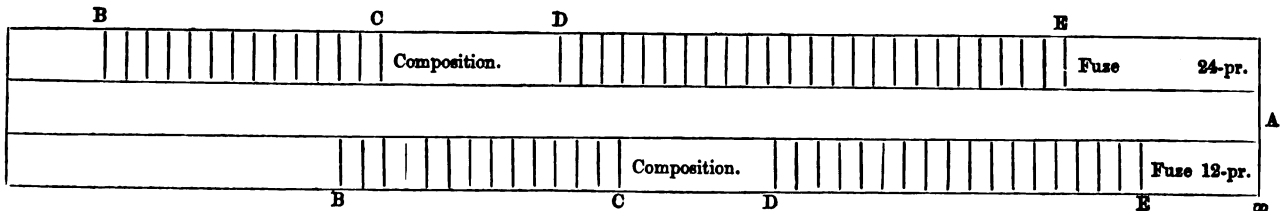
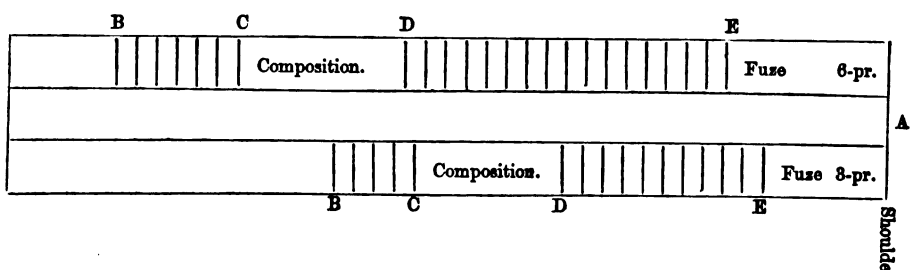
AB denotes the greatest length to which the Rocket Composition can be bored into, so as to leave 1·5 inch over the end of the cone in the 24-pounders, and one inch in the other natures.

AB is in the 24-pounder, 7·8 inches;
in the 12-pounder, 6·2 inches;
in the 6-pounder, 4·7 inches; and
in the 3-pounder, 3 inches.

AD is the distance from the surface of the Shell to the inner extremity of the Fuse, and is—

in the 24-pounder, 4·9 inches;
in the 12-pounder, 3·5 inches;
in the 6-pounder, 2·9 inches; and
in the 3-pounder, 2 inches.





BC is the thickness of the Composition available for boring into, after leaving the above thickness over the cone, and is—

in the 24-pounder, 1·8 inch;
in the 12-pounder, 1·8 inch;
in the 6-pounder, ·8 inch; and
in the 3-pounder, ·5 inch.

DE is the length of Fuze, and is—

in the 24-pounder, 3·3 inches;
in the 12-pounder, 2·5 inches;
in the 6-pounder, ·2 inches; and
in the 3-pounder, 1·3 inches.

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1st June, 1846.

Colonel TURNER, C.B., in the Chair.

No. 12.—*Report of Experimental Rocket Practice in Canada.*

The following practice was carried on by order of the Master-General of the Ordnance at Quebec, Montreal, and Kingston, during the winter of 1845 and 1846, to ascertain whether extreme cold has an injurious effect upon rockets, and if so, whether the action is upon the case or composition of the rocket, also whether the effect is temporary, *i.e.* during the continuance of cold only, or whether it is permanent.

It appeared from the practice, that rockets are so much affected by severe cold, as to render them dangerous to those employed in using them, but the officers, by whom the practice was carried on, did not consider the injury to be permanent; it also appeared that the 12-pounder rocket was more liable to burst than the 6-pounder, although the latter could not be relied on. The following is an extract from the report of Colonel F. Campbell, Commanding the Royal Artillery in Canada, to the Director-General of Artillery:—

"The cases of the rockets which burst at Montreal seemed to separate where the head of the rocket is attached to the case, which appears also to have been the case in several instances at Quebec. This at least seems to show a weakness in this part of the rocket; and knowing how extreme cold lessens the tenacity of metals, I am now inclined to attribute the bursting of the rockets in most instances to this cause, rather than to the composition being injured, and the rockets being serviceable at higher temperatures seems to corroborate this opinion."

Colonel Campbell then suggested that a proportion of 12 and 6-pounder rockets should be made with stronger cases, and sent to Canada for trial in severe cold.

The following instructions were drawn up for the guidance of the officers by whom the practice was carried on, with a view of pointing out the manner of proceeding most likely to lead to the elucidation of the points brought under their consideration. The rockets were to be examined at the laboratory previous to their being issued, and again by the officers previous to their being fired, lest any should be used for the experiment which did not appear perfectly serviceable, and any unusual appearance upon the rocket was to be recorded, and all dates or other marks to be noted in the practice report. It was directed also, that a

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portion of the rockets should be fired in the coldest weather that it was practicable to do so, a portion also to be reserved for the purpose of being fired when the mercury in the thermometer stood above the freezing point, and others on one or two days when the temperature was between those two extremes, for instance, the greatest degree of cold being − 16°; then those days when the mercury was at 0° and + 16° (or near those degrees of temperature) were to be selected. Also, in order to ascertain whether the injury sustained by the rockets from severe cold was permanent or otherwise, a proportion was to be taken out in addition to those intended to be fired, in order that they should be subjected to precisely the same degree of cold as the others, and then to be retained for the purpose of being fired when the mercury stood above the freezing point, with those previously kept for that purpose.

It was desired by His Excellency the Commander of the Forces in Canada, that a few of the rockets fired in the coldest weather should be placed in a heated room, as near the place selected for firing them as possible, and to be protected from the cold on being moved thence for the purpose of being fired.

With respect to the practice at Quebec, of those rockets which burst, the cases of 13 were found either in the tube, or close by it: their condition was as follows:—

12-*pounder Shell Rockets.*

	No.
Split in the tube, stick remaining	1
Cases uninjured, shells blown out	2
Cases uninjured, except at the top, which was burst open by the explosion of the shell . .	5
A small fracture near the touchhole in the side of the case, the shot not projected	1

6-*pounder Shot Rockets.*

Cases uninjured, shot not projected	1
Cases uninjured, shot blown out	3
Total	13

A large majority of the rockets which were fired at low temperatures having burst prematurely, led to the conclusion that in their present state they were decidedly unfit for service in extreme cold; but in the opinion of the officers under whom the practice was carried on, the rockets were not permanently injured by the action of the frost, as, when again restored to a moderate temperature, they were comparatively serviceable.

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Rocket Practice.

Date and thermometer.	Weight.	Description.	Elevation.	Range.	Manner of treatment.	Result.	Marks.
	pr.		°	yds.			
Jan. 21, 1846. Thermometer + 15° to + 17°.	6	Shot	12½	1000	Fired as received from Ordnance stores	Burst on leaving tube	1837—2.
	6	...	...	...	Ditto ditto ditto	Good line, full range	1837—1.
	12	Shell	13¾	...	Exposed for 47 hours to a range of temperature from − 9° to + 8°.	Burst in tube, and tube destroyed.....	1826, Fuze 8″. Repaired Feb., 1838.
	12	...	...	...	Exposed to the same, afterwards put in a room for half an hour, temperature + 85°.	Ditto ditto	Ditto
	6	Shot	12½	...	Ditto ditto ditto	Burst in tube	1837—1.
	12	Shell	13¾	...	Exposed for 5 days to a range of temperature from − 9° to + 14°.	Burst on ignition	1824, Fuze 8″. Repaired Feb., 1838.
	12	...	...	...	Ditto ditto ditto	Burst at 100 yards	Ditto
	12	...	...	...	Ditto ditto ditto	At the distance of 50 yards returned to the rear and burst.	Ditto
Jan. 24, 1846. Thermometer + 11° to + 14°.	6	Shot	12½	...	Ditto ditto ditto	Good line, full range	1837—1.
	6	...	...	...	Ditto ditto ditto	Burst at 150 yards	1837—1.
	6	...	...	...	Ditto ditto ditto	Burst in tube.....	1837—2.
	6	...	...	...	Ditto ditto ditto	Good line, grazed at 600 yards	1836—1.
	12	Shell	13¾	...	Covered with a composition,* and afterwards exposed for 47 hours to a range of temperature from + 10° to + 14°.	Burst at 100 yards.....	1824, Fuze 8″. Repaired Feb., 1838.
	6	Shot	12½	...	Ditto ditto ditto	Burst in the tube	1836.
	6	...	...	...	Exposed for 5 days to a range of temperature from − 9° to + 14°, afterwards put into a room ¾ hour, temperature + 120°.	Good line, full range	1836.
	12	Shell	13¾	...	Ditto ditto ditto	Grazed 500 yards, full range	1824, Fuze 8″. Repaired Feb., 1838.
	12	...	...	...	Ditto ditto ditto	Grazed 600 yards, full range	Ditto
	12	...	...	...	Fired as received from the Ordnance stores	Burst in the tube	Ditto
	12	...	...	...	Ditto ditto ditto	Burst to right, 6 yards	Ditto
	12	...	...	...	Ditto ditto ditto	Burst on ignition	Ditto
	6	Shot	12½	...	Ditto ditto ditto	Good line, full range	1836—1.
	6	...	...	...	Ditto ditto ditto	Ditto ditto	1836—2.

* This composition was a mixture of linseed oil, wax, &c., for the purpose, if possible, of excluding the frost.

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Rocket Practice—continued.

Date and thermometer.	Weight.	Description.	Elevation.	Range.	Manner of Treatment.	Result.	Marks.
	pr.		°	yds.			
Feb. 9, 1846. Therm. from −2° to 0°.	12	Shell	13¾	...	Covered with a composition,* and afterwards exposed for 14 days to a range of temperature from + 18° to − 14°.	Burst a few yards to the right	1824, Fuze 8″. Repaired Feb., 1838.
	6	Shot	12½	...	Ditto ditto ditto	Burst at 60 yards	1836.
Feb. 9, 1846. Therm. from −2° to 0°.	12	Shell	14	1000	Exposed for 14 days to a range of temperature from + 18° to − 14°, afterwards put into a room for 3 hours, temperature + 90° to + 110°.	Graze 600 yards, full range.....	1824, Fuze 8″. Repaired Feb., 1838.
	6	Shot	13	...	Ditto ditto ditto	Burst on ignition	1837—1.
	12	Shell	14	...	Fired as received from Ordnance stores	Burst at 50 yards	1824, Fuze 8″. Repaired Feb., 1838.
	6	Shot	13	...	Ditto ditto ditto	Burst on ignition	1836.
March 9, 1846. Thermometer from + 35° to + 36°.	12	Shell	16	...	Exposed for 44 days to a range of temperature from − 16° to + 36°, afterwards placed in a room for 1 hour, temperature + 105°.	Good, first graze 800 yards	1824, Fuze 8″. Repaired Feb., 1838.
	12	...	...	...	Ditto ditto ditto	Good, first graze 600 yards	Ditto
	6	Shot	14	...	Exposed for 44 days to a range of temperature from − 16° to + 36°.	Good, first graze 300 yards	1837—1.
	6	...	...	...	Ditto ditto ditto	Good, first graze 700 yards	Ditto
	6	...	...	...	Fired as received from Ordnance stores	Good, full range	Ditto
	6	...	...	...	Ditto ditto ditto	Ditto ditto	1837.
	6	...	...	...	Ditto ditto ditto	Ditto ditto	Ditto
	6	...	...	...	Ditto ditto ditto	Ditto ditto	Ditto
	12	Shell	16	...	Ditto ditto ditto	Graze 50 yards, and buried in the snow, composition good.	1824, Fuze 8″. Repaired Feb., 1838.
	12	...	...	...	Ditto ditto ditto	Good, first graze 900 yards	Ditto
	12	...	...	...	Ditto ditto ditto	Good, full range	Ditto
	12	...	...	...	Ditto ditto ditto	Burst at 300 yards	Ditto

* This composition was a mixture of linseed oil, wax, &c., for the purpose, if possible, of excluding the frost.

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Report of Rocket Practice directed against a Snow Butt; Range 436 *yards, at Montreal, 7th March,* 1846.

Nature of Rocket.	No.	Date.	Elevation.	First Graze.	Extreme Range.	Therm.	Remarks.
			deg.	yds.		°	
12-Pr.	1	1824; repaired in 1836.	7	100	Unknown.	8 A.M. 8.	Ricocheted.
	2		12	340	...		Composition bad. Shell went up to butt and burst, stick and rocket case to rear of battery from rocket frame.
	3		12	400	...		Composition bad. Shell burst short.
	4		12	...	...		Composition bad. Shell burst near tube.
	5		12	...	...		Composition bad. Shell burst at muzzle of tube, and broke off end of tube.
	6		12	...	Unknown.		Composition bad. Burst at muzzle of tube, and rendered unserviceable.
6-Pr.	1	...	7	220	Unknown.	12 noon 9°.	Composition good. Practice carried on at noon.
	2	...	12	200	Over butt.		
	3	...	12	460	...		
	4	...	12	440	...		
	5	...	12	100	To butt.		
	6	...	12	600	Over butt.		

Report of Rocket Practice carried on at Kingston, C.W., in January and February, 1846.

Date on which the Practice was carried on.	Temperature.	Nature of Rocket.	Number of Rounds.	Range in Yards.	Elevation.	First Graze in Yards.	Result of Rocket. Right Yards.	Result of Rocket. Left Yards.	Remarks.
1846.		prs.			°				
28 Jan.	38½°	6	1	700	15	650	100	...	.....
		12	2	700	17	80	...	...	Good line.
		6	3	700	15	750	200	...	.....
		12	4	700	17	1000	300	...	.....
30 Jan.	38°	6	1	700	10½	400	...	...	Good line.
		12	2	700	11½	300	20	...	Rocket bad.
		6	3	700	10½	800	...	...	Good line.
		12	4	700	11½	600	...	...	Good line.
		6	5	700	10½	750	19	...	.....
		6	6	700	10½	670	30	...	.....
4 Feb.	2° below zero.	6	1	750	10½	600	20	...	.....
		12	2	750	11½	650	10	...	.....
		6	3	750	10½	750	7	...	.....
		12	4	750	11½	650	12	...	.....
		6	5	750	10½	780	25	...	.....
		6	6	750	10½	780	30	...	.....
		6	7	750	10½	750	20	...	.....
		6	8	750	10½	400	15	...	.....

The above experiments were referred to the Director of the Royal Laboratory for examination and report. The following is a copy:—

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"Royal Laboratory, Woolwich,
17th May, 1846.

"With respect to this report, I have the honour to observe that of the 40 rockets fired at Quebec, 23 had experiments of temperature tried upon them, and 13 burst prematurely, and 10 burnt well; 17 were fired as received from the Ordnance stores, and 6 burst prematurely, and 11 burnt well. Also, in the practice at Montreal and Kingston, there is no mention of any experiments having been tried upon them, therefore it may be concluded that they also were fired as they came from the Ordnance stores, and 24 burnt well, and 6 burst prematurely. It is therefore evident that those rockets which had not been subjected to experiment, were much better than those which had; however, it is not to be denied that those rockets, upon the whole, evinced considerable defect and deterioration. The iron of the rocket cases is of course subject to contract and expand according to the temperature to which it is exposed, and unless the mass of the composition which is enclosed in it be similarly affected, a separation of it from the case might ensue, and cause a premature explosion; but I should say that sudden transition from one extreme of temperature to another, ought by all means to be avoided if possible.

"The separation of the head of the rocket from the case is the natural consequence of a premature explosion, and does not at all indicate that the head would not have been held on to the case if the burning had been regular.

"The evidence of the composition of the rockets being recoverable from a deteriorated state, by subjecting them to a high temperature after exposure to extreme cold, is not so positive as Colonel Campbell seems to think, 3 of those so treated having burst prematurely, and 4 having burnt well. I am inclined to attribute this evil of premature explosion to internal corrosion of the case from exudation of damp from the rocket composition. Measures have of late years been taken to prevent this; and I recommend that the whole of the rockets in Canada which are of old date, should be replaced by new ones as soon as the change can be effected.

"(Signed) JAMES COCKBURN,
Director."

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No. 13.—*Effect of Shot and Shell upon Snow and Ice.*

Report of Experiments carried on at Montreal during the Winter of 1845-6, for the purpose of ascertaining the effect of Shot and Shells upon Defences constructed of Ice and Snow, by order of Lieutenant-General Lord Cathcart, K.C.B., Commander of the Forces, &c. &c.

Montreal, March 26, 1846.

The object of the experiment was to ascertain the effect of the fire of artillery upon snow and ice, when raised so as to form a parapet, with a view of determining whether such materials might not, under certain circumstances, be advantageously employed in the formation of defensive works.

For this purpose, a butt of the materials above mentioned, was erected on a small island, in the river St Lawrence, about 400 yards south of the island of St Helens, upon which the guns employed in the experiment were placed, the exact range being 440 yards.

The dimensions of the butt, at the base, were 66 feet by 47, and it was carried up with a slope of two inches to a foot. The first eight and a half feet was composed of ice, which had been forced upon the island by the strong current of the river, bringing down large masses of ice, which being stopped by ice formed lower down the stream, is here jammed together, and thrown up in irregular masses to a considerable height. The ice was formed into a compact mass, by breaking it down with sledge-hammers and mauls, and throwing water upon it, which from the intensity of the cold (usually about zero) quickly formed it into nearly a solid mass. The remainder of the butt was formed of snow, rammed down with paving rammers, and water was thrown upon it three times a day. From the dryness of the snow, it was found impossible to give it the proposed slope, it was therefore found necessary to plaster it with wetted snow.

It may here be mentioned, that after being formed, the snow may be cut to any slope, and will even stand if cut perpendicularly. The height of the butt was 20 feet 6 inches, but this height was only carried to a thickness of 18 feet at top; the remainder being carried to a height of 15 feet.

The practice commenced on the 29th January, and concluded on the 7th March: shot and shells from the following natures of ordnance were fired.

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		Shot.	Shells.
Iron	24-pounder gun . . . . . 9 feet	16	10
	18 „ . . . . . „	10	0
	12 „ . . . 8 feet 6 inches	10	10
	9 „ . . . „	10	0
	32-pounder carronade	2	0
	24 „ „	2	0
Brass	9-pounder gun	8	0
	6 „ light	12	0
	24 „ howitzer	4	8
	12 „ „	8	16
		82	44

The shells for 24 and 12-pounder guns were fired with howitzer charges.

The following is the result of the shells before enumerated:—

	Shot.	Shells.
Struck the butt direct	64	32
Grazed previous to striking the butt	11	4
Grazed and went over.	4	0
Grazed, and did not reach the butt	1	0
Went over before grazing	1	1
Struck close to top, and exploded	0	2
Burst previous to reaching the butt	0	5
Struck close to top, and glanced off	1	0
	82	44

In order to ascertain the penetration of the shot, a trench about 8 feet in width was cut parallel to the face, at a distance from it of 13 feet at top, and 16 feet at bottom.

The left side was also cut through from the trench to the front, to ascertain the penetration and result of the shells. The number of shot and shells found in the butt was—

	Shot.	Shells.
32-pounder	..	..
24 „	12	14
18 „	6	..
12 „	5	9
9 „	11	..
6 „	8	..
	42	23
Remaining in butt . . .	31	13

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It being desirable to ascertain how long the snow butt would withstand the heat of spring and summer, the search for the shot was not continued further, and the trenches which had been cut were filled in. This for the present prevents our ascertaining with certainty the exact penetration of each nature of shot in the different materials of which the butt is composed; but there is now sufficient data collected for all practical purposes, and it is hoped that the penetration of the shot still remaining, which are principally in the ice, will yet be ascertained.

Penetration of Shot in Snow Butt.

		Penetration in Snow.		Penetration in Ice.	
		Greatest.	Mean.	Greatest.	Mean.
		ft. in.	ft. in.	ft. in.	ft. in.
Iron	32 pounder carronade	...	...	...	...
	24 „ „	...	...	7 6	7 4
	24-pounder gun	16 3	15 1	...	...
	18 „ „	17 0	15 9	8 2*	8 2
	12 „ „	...	...	...	...
	9 „ „	11 0†	11 0	8 1	7 1
Brass	9 „ „	12 5	10 6	...	...
	6 „ „	9 8	9 2	6 1	5 9
	24-pounder howitzer	14 0	13 6	...	...
	12 „ „	13 0*	13 0	7 5†	7 5

* One shot found. † Two shots found.

The preceding table will appear to contain some discrepancies; as, for instance, the penetration of the 24-pounder shot being less than that of the 18-pounder. This may be explained by most of the 24-pounder shot being lodged in the lower part of the butt; and as these were not found to have penetrated to the trench, 16 feet, a few rounds were fired after the trench had been cut. The result was, that the shot penetrated the part in front of the trench, and buried themselves about 4 feet in the part behind it, making a total average penetration of about 15 feet. As, however, there was no intervening space when the other natures were fired, the comparative penetration may not be perfectly correct.

Of the shells fired, it will be remarked that five burst previous to reaching the butt. This arose from the first shells fired lodging in the butt, and penetrating, as was supposed, so far before exploding, as not to have any apparent effect (this was afterwards found to be correct).

The fuzes for these shells were cut to 1 inch in length, and bored up to ·5 inch. The fuzes were afterwards bored up to ·3 and ·2 inches; but in consequence of some of the fuzes not having the height of the composition marked on the outside, and other accidental marks having been mistaken

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for it, caused the fuzes to be incorrectly bored up, and the shells to burst short before the mistake was discovered.

Of the 23 shells found in the butt, 15 burst, and 8 were found not to have burst (the fuzes of 5 of these 8 were found not to have ignited).

Of the 15 which burst, 9 (four 5½ and five 4⅝) appear to have been effective in making the breach, the others having penetrated too deeply to produce any material injury to the butt.*

The object in view, being to ascertain the penetration of the different natures of shot, and not to effect a breach, the fire was directed to different parts of the butt. No material injury was in consequence effected by the shot. The shot penetrated without causing many splinters (except when the top was grazed), making an opening about twice the diameter of the shot, which closed completely up, at a distance varying from 4 to 11 feet; but in only one case could the penetration of the shot be ascertained, until the butt was cut into, and it was evident that a practicable breach could not be made in such materials with a less weight of shot than was fired against it†, nor is it very certain that one would have been effected with the shot fired, had that been the object in view.

After each day's firing, the shot-holes were filled up, making the butt as strong as when first erected.

The effect of shells was much more considerable (though on this occasion the greater number were not effective, for the reasons before explained); nine shells making a very considerable breach, and two or three more effective shells would have made a breach of about 12 feet wide. As however the effect of shells had been ascertained, and a considerable number expended, it was not considered desirable to continue the experiment.

It is however evident, that 30 or 40 effective shells would form a considerable breach in a parapet of these materials.

From the readiness with which a parapet of this description may be formed, it might prove of essential service in this country, particularly in the defence of open towns and villages against musketry, or field-pieces. Broken parapets might also be quickly repaired, and earthen works increased in strength, by removing the snow from the ditches, and adding it to the parapet.

Snow might also be found useful in forming traverses in permanent works.

In estimating the thickness for such works, it should be borne in mind, that the resistance would vary considerably, according to the state of the

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* The shells penetrated about eight feet.

† Weight of shot fired against butt, 1222 lbs.

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weather, in which the work was erected. Mild days and very severe nights would probably be the most favourable, but to form a compact mass, a considerable degree of cold is evidently necessary; much, of course, will also depend on the care that is taken in ramming the snow.

When glare ice of considerable thickness can be obtained, it would probably be found most effective to saw it into blocks (which can be done with facility), of which a wall of great strength might be formed.

The butt was erected by the engineer department, under Col. Holloway, and the practice carried on (under my direction) by Major Evans, commanding the Royal Artillery at this station.

(Signed) F. CAMPBELL, *Col. Staff,*
Commanding Royal Artillery.

Thermometer at Montreal on each day of Practice.

	Noon.
29th January	+ 22
3rd February	+ 13
7th „	+ 22
10th „	— 4
14th „	+ 14
17th „	+ 10
7th March	+ 22

Memorandum showing the number of Persons employed, and Implements, &c. used in the construction of the Butt:—

		No. of Days.
Lieutenant Cox, Royal Artillery, Acting Engineer...		18
1 Serjeant, Royal Artillery, Superintendent		
1 Subaltern	Working party of the Line	
2 Serjeants		
50 Privates		
4 Horses and Sleighs .	Working party, Royal Artillery	5
4 Drivers		

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Tools, &c.

Wheelbarrows	10
Iron shovels	50
Pick-axes	25
Mauls	16
Paving rammers	12
Water buckets	20
Sledge hammers	2*
Wooden snow shovels	15
3-in. planks	20
Trestles	10

Estimated work of one man per diem, in erecting a parapet of snow, 100 cubic feet.

Dimensions of Butt.

Length :—

At bottom	66 feet.
At top	54 „

Breadth :—

At bottom.	47 „
At top, front	18 „
„ rear	14 „

(Signed) F. CAMPBELL, *Col Staff,*
Commanding Royal Artillery.

Mortar Practice.

Quebec, 17th March, 1846.

The thickness of the ice on to which the shells from mortars were projected, on the 26th and 31st January, 1846, varied from two to three feet in solidity. In some parts, the snow which had fallen upon it had melted from temporary thaw, and frozen subsequently into an upper coat of ice, also of great strength, and irregular in its surface; in other parts blocks drifted together were part of the original formation of the ice. The one shell which sunk three feet fell on an imperfect portion of the ice, soft and loose at the surface.

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* A greater number would have been useful.

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Report of Experimental Mortar Practice on the Ice on the River St Charles, under the direction of a Board of Officers, by order of his Lordship the Commander of the Forces, for the purpose of ascertaining the effect of Live Shells upon Ice, on the 26th and 31st January, 1846.

Date and Therm	Nature of Ordnance.	Elevation.	Charge.	Bursting.	Fuze.	Range.	Fell.				Fuze.			Remarks.
							Right.	Left.	Under.	Over.	Good.	Long.	Short.	
		deg.	lbs. oz.	lbs. oz.	lbs oz.	yds.	yds. ft.	yds. ft.	yds. ft.	yds. ft.				
26th Jan. 1846. Therm. + 14°	8-inch	45	0 12	0 1	2 1	550	...	30 0	...	70 0	Yes.	...	...	Made no impression.
		...	0 12	1 14	2 1	...	...	25 0	...	45 0	...	...	Yes.	
		...	0 12	1 14	2 4	...	...	35 0	...	50 0	...	Yes.	...	Burst before reaching the ice.
	13-inch	...	2 4	6 12	2 4	...	...	30 0	...	50 0	Yes.	...	...	.....
		...	2 4	6 12	2 4	...	Good line.		...	...	...	Yes.	...	The weight of the shell made no impression, burst on the ice, and made holes 9 feet in circumference at top, 9 inches at bottom, and 3 feet deep, admitting the water. The surrounding ice was not damaged.
		...	2 4	6 12	2 5	...	Good line.		...	10 0	...	Yes.	...	
	10-inch	...	1 3	2 10	2 4	...	Good line.		...	50 0	Yes.	...	...	Burst in the ice, making holes about 18 inches deep.
		...	1 3	2 10	2 4	...	...	5 0	...	10 0	...	Yes.	...	
		...	1 3	2 10	2 4	...	Good line.		...	50 0	Yes.	...	...	
	8-inch ...	45	1 3½	2* 12	2 7	1000	...	50 0	...	30 0	...	Yes.	...	Penetrated loose ice to the depth of 3 feet; when it burst, did not at all affect the ice.
31st Jan. 1846. Therm. + 18°	10-inch ...	...	1 14	4* 10	2 7	...	Good line.		...	20 0	Yes.	...	...	Made no impression.
	13-inch ...	...	3 8	8* 12	2 9	...	...	6 0	10 0	...	...	...	Yes.	
	13-inch ...	30	4 4	6 12	1 9	...	10 0	...	100 0	...	...	...	Yes.	
	10-inch ...	...	2 4	2 10	2 3	...	Good line.		30 0	...	...	...	Yes.	Did not burst.
	8-inch ...	...	1 5½	1 14	2 3	...	20 0	...	...	...	...	...	Yes.	Made no impression.
	8-inch ...	15	1 9	1 14	1 7	...	...	40 0	...	...	Yes.	...	...	
	13-inch ...	...	5 0	6 12	1 7	...	10 0	...	...	...	Yes.	...	...	
	10-inch ...	...	2 10	2 10	1 7	...	...	20 0	...	30 0	Yes.	...	...	

N.B. No wooden platforms made use of; the mortars were laid on the ice. * Filled with powder.

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Report of Experimental Practice carried on at Quebec, on the Ice on the River St Charles, under the Direction of a Board of Officers, for the purpose of ascertaining the Effects of Live Shells upon Ice, on the 19th March, 1846.

Date and Therm	Nature of Ordnance.	Elevation.	Charge.	Bursting	Fuze.	Range	Shells Fell.				Fuze.			Remarks.
							Right.	Left.	Under.	Over.	Good.	Long.	Short.	
19th March, 1846. Thermometer + 40°.	Mortar. 13 inches.	75°	lbs. oz.	lbs. oz.	in. 10ths	yds.	yds. ft.	yds. ft.	yds. ft.	yds. ft.				
			4 0	0 3	4 5	600	Good line.		170 0	...	Yes	...	...	Shell, filled with sand, penetrated a solid block of ice 2½ feet: did not reach the water.
			4 0	6 12	4 5	...	Good line.		160 0	...	...	Yes	...	Penetrated 3 feet in thickness: burst underneath, making holes about 7 feet in circumference.
			5 0	8 8	6 5	...	...	3 1	...	...	...	...	...	ditto ditto
			5 0	8 8	6 0	...	Good line.		50 0	...	...	Yes	...	Penetrated through ice 3 feet thick: burst underneath, throwing up a great quantity of ice.
			5 0	8 8	5 7	...	Good line.		...	20 0	...	Yes	...	ditto ditto
			5 0	8 8	5 4	...	Good line.		10 0	...	Yes	...	...	ditto ditto

N.B. The surface of the ice on which the shells fell was covered with water, caused by the thaw of the snow.

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Extract of a letter from Captain Warburton, dated Quebec, 21st March, 1846.

"The ice was fairly broken through, but not starred, by either the concussion above or the explosion underneath : the shells burst in the mud, at the bottom of the river, shooting the black stuff up through the hole in the ice. It is right to say that the ice was not nearly so hard on the surface as in the former practice ; indeed, the upper stratum was thawed into soft snow and water. I think, however, that at the strongest, the 13-inch shell fired at 75°, would be sure to break it. Finding that the shells penetrated the ice, we filled them with bursting powder, but that did not appear to cause any additional effect.

Report of Practice with a 10*-in. Iron Mortar, from the advanced Battery at Fort Henry, on the* 13*th January,* 1846, *as directed by General Order of* 12*th January,* 1846.

The height of the battery above the lake is about 85 ft., the mortar was elevated 45°. The charges were, 1st round, 1 lb. of powder for 600 yds. 2nd and 3rd rounds, 4 lbs. of powder for 2400 yds.

The object of firing was with a view to ascertain the capability over a principal road leading across the ice, and which in the winter is always made the communication between the United States and Kingston, and to try the effect of the shells in breaking the ice.

Effect, 1st round.—The actual range was 497 yds., and a hole was made in the ice about 18 in. in diameter.

2nd round.—The range was 2060 yds., making a hole about 6 ft. in diameter.

3rd round.—The range was 2000 yds., making a hole about 4 ft. in diameter.*

(Signed) C. Dalton, *Lieutenant-Colonel,*
Commanding Royal Artillery, Canada West.

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* Thickness of ice about nine inches.

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Annual General Meeting, 29th June, 1846.

Major-General Sir THOMAS DOWNMAN, C.B., K.C.H., in the Chair.

1. The Report of the Committee for the year 1845-46, was read; and the following Members were appointed to act on the Committee for the ensuing year, viz.—

Major-General Webber Smith, C.B.
Lieut.-Colonel D. Grant.
„ C. C. Dansey, C.B.
„ J. N. Colquhoun.
Captain J. Tylden.
„ E. F. Grant.
„ C. V. Cockburn.
„ C. J. B. Riddell.
Asst.-Surgeon J. S. Litle.

2. The Accounts for the year ended 30th April, 1846, were laid before the Meeting, and passed, the following is an Abstract:—

Abstract of Accounts of the Royal Artillery Institution to the 30th April, 1846.

INCOME.	£	s.	d.
Balance Credit May 1, 1845.....	125	1	9
Annual Subscriptions of Members	126	5	0
Entrance Subscriptions of Members	12	15	0
Back Subscription of Captain E. Morgan, 1844.....	0	5	0
Subscription to German class ...	21	4	4
Subscription to French class ...	12	13	4
Dividend to Jan. 5, 1846	5	7	10
	£303	12	3

EXPENDITURE.	£	s.	d.
Books, Binding, and Stationery	8	19	2
Printing	10	5	0
Overcharged { Lt. Parson, 1844 ...	0	10	0
Overcharged { Lt.-Col. W. E. Jackson, 1845.....	0	7	6
German Instructor	47	10	0
French Instructor	38	7	0
Insurance to Michaelmas, 1846	3	12	9
Clerk's Salary, at 1s. per day	18	5	0
Purchase of Stock	29	5	3
Fuel and incidents.....	14	0	9
Reparing instruments	10	4	6
Furniture and fittings	11	13	6
Unpaid Subscriptions	6	2	6
Balance Credit, May 1, 1846 ...	104	9	4
	£303	12	3

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31st July, 1846.

Major FURNEAUX, R.A., in the Chair.

No. 14.—*Remarks on the Armament of Fortresses and permanently fortified Posts.*

The general efficiency of the artillery service so essentially depends upon good previous arrangements, sound organization, and a sufficient store and distribution of *matériel*, that it is desirable all officers should make themselves acquainted with the general principles that ought to be observed under the various circumstances of service.

Of all the duties whose successful performance depends upon previous consideration and arrangement, there is none more important than the due armament of fortresses and permanently fortified posts.

The armament being understood to include not only the ordnance and carriages, but also the ammunition and stores essential to a good defence.

It is true, that on many occasions, it may not be possible to obtain all that may be desired; but on the other hand it will frequently occur, that by wise foresight and good management, the *matériel* indispensable for the defence may be procured, and when obtained, the most may be made of it by judicious distribution and arrangement. It is certain these duties are neither brilliant nor showy, and the necessary detail may appear tedious and uninteresting, and yet, on them will mainly depend the efficiency of the artillery when the day of action arrives.

It may be well here to cite the remark of the celebrated Carnot. "That a fortified town is, properly speaking, but a vast battery, that if this battery be without guns, or these guns without gunners to serve them, or lastly, if the garrison be without provisions and stores, the place will be but an advantageous position, which will have been fortified for the profit of the first aggressor who may choose to attack it." He adds, "The art, then, of well providing a place with everything necessary for its defence, is of as great importance as that of properly fortifying it."

The example of the Duke of Wellington may be appealed to, as showing the importance of going into details. They who are familiar with his published despatches, must be aware how carefully he states the proportions of ordnance and ammunition necessary for different operations, and

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how carefully he provides for the transport of Artillery stores, showing even the proper load for a cart, and the distance it should travel in a day.

In short, giving detailed instructions on points which at first sight might appear beneath his consideration, but on which great results depended, or he assuredly would not have given them his attention.

Perhaps less interest has been felt in the armament of fortresses, in consequence of the very few sieges which the British Army has been called upon to sustain for a long course of years. Our operations have generally been offensive, but we know not how soon we may be called on to defend our foreign possessions, and it is obvious that the development of steam navigation and the general introduction of railways, as affording the means of rapidly concentrating large bodies of troops and stores of *materiel*, have strongly impressed our Government with the necessity of putting our coasts and harbours in a state of defence.

This measure can only be based on the possibility of England being called to defend herself; and hence all defensive arrangements assume augmented importance.

Before fixing the armament of any fortified position, it will be necessary to study it thoroughly, both as an isolated work, and in reference to its relation with the general system of defence, of which it forms a part. The armament cannot be determined from the simple consideration of the extent of the place, account must be taken of the disposition of the works, and the nature of the surrounding ground; and to fix it properly, it is necessary to enter into all the details of the presumed attack and defence, and to consider attentively the particular objects and bearing of every part of the defences capable of being armed with cannon.

It will be well to remember that, while the general principles of war must ever remain the same, the science and practice of artillery are progressive. Notable changes in the *matériel* of the artillery have been introduced since 1815, and no officer can enter with advantage upon the question of armaments, unless he be thoroughly acquainted with the latest alterations and improvements in every department of garrison and siege Artillery service.

It is necessary to provide ordnance and ammunition sufficient for a vigorous defence, and yet to avoid accumulating such a store, that the enemy shall find a large supply at his command if he take the place, and the garrison be prevented from destroying what has not been expended in the defence.

As a general rule, the ordnance of a besieged place is only used against the besiegers' troops, or such trenches or batteries as he may actually throw

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up in the field, and, therefore it is not necessary that it shall be of very heavy lalibre. Besides the artillerymen of a garrison being necessarily limited in number, the labour of working heavy ordnance should be spared, if possible, and the great consumption of powder should also be considered.

It is, moreover, to be remembered that in a place open to attack in more than one front, it is not advisable, or indeed generally possible, from the excessive quantity which would be required, to arm fully all the fronts before the enemy has broken ground, and indicated by the nature of his attacks the front by which he purposes to penetrate into the place. The greater portion, therefore, of the artillery of the place, must be put into battery in the works after the enemy has broken ground, and it will be also necessary during the progress of the siege to modify the distribution of the artillery as the attacks become developed.

It must likewise be expected that several pieces will be dismounted, which it will be desirable to replace or remount.

When the situation of the battery is such, that it must be kept constantly armed, because it commands some passage or point of importance, liable from its nature to sudden and unexpected attacks, such as sea batteries in general, and land batteries bearing on some approach or communication vital to the security of the place, the questions of rapidly arming and of transferring the guns to some other battery, are or minor consideration.

In such cases, taking due account of the expenditure of heavy ordnance, such pieces may be chosen as afford the most effective fire, and they may be mounted in the mode most convenient for working, without reference to the facility of moving them. A great multiplication of calibres should be avoided, particularly in places of small extent, where the total number of pieces cannot be considerable.

In arming particular batteries, it is important that but one calibre should, if possible, be introduced.

The less the variety of calibres, the less risk of confusion in serving out ammunition and stores, and the smaller aggregate supply of everything will suffice, and every arrangement will be simplified.

In a service so complicated, and with duties so multifarious as those of the Artillery, simplicity of arrangement should never be lost sight of.

It is a rule, never to place in detached works and outworks not deemed capable of a very long resistance, any pieces of such calibre as shall leave at the disposal of the besieger any battering guns or heavy mortars, or howitzers, to be used against the body of the place, after the advanced

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works have fallen. With regard to land defences, in general the 24-pr. of 50 cwt., the 10-in. howitzer, and 10-in. mortar are the heaviest pieces which need enter into the armament of a fortress. The works of the besieger will rarely be so solid, as that nothing less than 32-prs. and 13-in. mortars will make an impression on them.

The 24-pr. of 50 cwt. has been hitherto a sufficiently powerful piece for our battering trains, and if so, it must be effective against the trenches and batteries of a besieger.

All things considered, the expenditure and means of serving one 13-in. mortar may be taken as equal to those required for two 10-in mortars, which would certainly produce the most annoyance to the besieger.

The absolute number of the heavier pieces must depend upon circumstances; but they need not in general amount to more than from one-fifth to one-fourth of the whole number composing the armament, and should be reserved exclusively for the body of the place, unless there exist special reasons for placing a proportion in an outwork.

The light and short 24 and 18-pr. guns bored up from 18-pr., 12-pr., and 9-prs., are commonly recommended for flanks and short lines of defence, in lieu of the carronades formerly used for such purposes. They may answer very well when but a few rounds are to be fired, but it must be remembered they are much too short for long-continued firing through embrasures.

Forts, according to their extent and importance should be armed, as to guns, exclusively with 18-prs., with 18 and 12-prs., or with 12-prs. alone; the allotment of howitzers and mortars being determined on the same considerations, the larger forts having 8-in. and 5½-in. mortars and howitzers, the smaller only 5½-in.

Outworks, under ordinary circumstances, should scarcely have heavier pieces than 12-prs., and 5½-in. mortars and howitzers, unless secure provision be made for withdrawing heavier pieces before the fall of the work.

It is obvious that the best proportion of mortars and howitzers for any given armament must vary according to the nature of the ground around the works. Where there is much cover or unseen ground within cannon-shot, the proportion of mortars and howitzers should be increased.

It may here be remarked, in reference to our iron howitzers, that they are, from their want of length, imperfectly adapted for firing through embrasures, and that it would be desirable to construct a long 8-in. gun exclusively for garrison and siege service.

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Such a gun of 9 ft. long, and weighing about 50 cwt., would be as readily moved as a long 24-pr. and could be constructed to bear a charge of 6 lbs., since the 8-in. gun of 8 ft. and 52 cwt. has a charge of 8 lbs. With a charge of 6 lbs., the range and penetration would be considerable, and the recoil would be easy.

Whatever the nature of the localities, a certain number of light howitzers and 5½-in. mortars will be found useful in a protracted defence. It must be expected as a general rule, that the artillery of the besieger will, in the end, prove superior, and the garrison will only be able to annoy him by bringing suddenly and unexpectedly the fire of a few pieces to bear on his attacks. These pieces must be light and manageable, and at the same time equal to throwing a projectile, capable of doing execution, such as 5½-in. or 4⅘-in. shells, or a heavy fire of case shot. The lighter howitzers might be useful to accompany sorties made in force. The light mortars can be served from any corner where cover may be found. At the late siege of the citadel of Antwerp by the French, they were so annoyed by the fire of the Dutch from small mortars, that they sent for a number expressly to combat that mode of defence.

It has been already stated, that a portion only of the armaments of fortresses may be considered as permanent, it being necessary that the greater part of the ordnance should be capable of being readily moved into battery and from work to work. But when we come to consider the garrison carriages and traversing platforms, and carriages in the British service, it is at once seen they do not meet the necessary condition of mobility. With the dwarf platform, the pivot hitherto used, must be built into the parapet when the work is constructed.

The pivots for the common traversing platforms, and the curbs for both descriptions must be permanently fixed and laid, and therefore, long before a siege is apprehended. Neither the dwarf nor common traversing platforms travel, but must be conveyed on a carriage, and the gun carriages designed for them must also be transported to the battery. The gun must be conveyed separately, and when all are on the spot, the placing the platform on the pivot, mounting the gun carriage and gun, are all operations demanding considerable time.

Our garrison carriages are not adapted for conveying the gun, which must be moved by means of a transporting carriage of some description, and when arrived at the battery, the operations of removing it from the transporting carriage, and mounting it on the gun carriage, remain to be performed on the spot.

The duties, therefore, of arming batteries with ordnance mounted

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on the existing garrison carriages and traversing platforms, and of transferring guns from one work to another, according to the progress of the attack, must always consume much time, be frequently embarrassed, and sometimes rendered impracticable by the fire of the enemy.

It is true that the ordinary garrison carriage is compact, occupies little space, and exposes a small surface to enfilading and ricochet fire; but then it requires the genouillière to be so low that a great mass of the parapet must be cut away to form the embrasure, and the gunners are consequently badly covered against direct fire.

In adopting the garrison carriage, a fortress seems to have been regarded as a ship, where the space between decks is low, each port has its gun, and, if need be, a gun is easily transported from port to port on the smooth deck.

From the foregoing considerations it would seem preferable that, with respect to pieces firing through embrasures, the use of garrison carriages should be restricted to that portion of the armament which is to be kept permanently mounted, and that the rest of the ordnance, which would be only required to be put in battery in case of actual siege, should be supplied with travelling carriages. Under this arrangement, in case of threatened attack, all the guns and howitzers could be mounted and parked, ready to be moved at once on their own carriages to whatever point they might be required. Another advantage would accrue from this arrangement. The armaments kept in store for actual siege would form battering trains, which would be available for offensive operations, if the circumstances of the war justified the withdrawal of a certain number of pieces from our fortresses.

With regard to guns on traversing platforms, it may be observed, that at points which it is not deemed expedient to arm permanently, or at least to establish permanent pivots and curbs, their place may in some degree be supplied by barbettes, as at the salients for guns and howitzers.

It is, however, to be remarked that the French attach so much importance to the mobility of their garrison artillery, that their *affût de place*, which is placed on a traversing platform, is capable of being limbered up, of transporting its gun ready mounted to the battery, and of being run on to the traversing platform, which is itself so constructed that it can be lowered behind to receive the gun-carriage, and be raised again when that is run forward into its place.

By the system advocated, fewer transporting carriages would be required than with our actual arrangement for garrison artillery.

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Whatever plan be adopted, a certain proportion of spare carriages should always be provided, and transporting carriages in proportion to the absence of other means of conveying the ordnance.

A sufficient number of gyns and other engines, as well as the necessary implements and tackle to mount guns in the various situations that may be required, should be thought of in time. Ammunition, small stores, and side-arms must be estimated according to the number and nature of the pieces, and the presumed duration of the defence, remembering that, as, when once a place is closely invested it must depend on its own resources, it is better to err on the side of excess.

The late Mr. Stace, so well known for his talents and services in the Ordnance Commissariat during the last French war, used to say, in reference, certainly, to offensive operations, that on whatever expeditions he had been there had existed a want of ammunition. His statement proves the necessity of attending generally to the question of sufficient supplies.

Although the armament be provided and stored in the place, it may exist there under three conditions:—

1st. The state of peace may be so profound that it may not be considered necessary to mount any guns. It is, however, always well to keep a light piece or two mounted, to flank all the gates or entrances into the place.

2nd. The place may be armed to resist a *coup-de-main*, that is, with guns mounted on traversing platforms at the salients of the bastions and ravelins, two or three pieces on each flank, and some field-pieces, ready to be brought into action, on the barbettes, which should always be expressly provided for them at the salients of the covered way and smaller outworks.

3rd. A fortress may be completely armed, which can seldom be required, or indeed be suitably effected until regularly besieged, and it is pretty well ascertained by which front the enemy proposes to make his way into the place. In this case, a certain reserve being, if possible, retained for emergencies, the front attacked and collateral works are fully armed, and two or three light pieces remain mounted on the flanks all round the body of the place, to sweep the ditches in case the besieger should attempt to carry the place by escalading any of the fronts not regularly attacked.

When a strong place is about to be put into a state of defence, every detail of the fortifications which bears directly on the service of the artillery merits the particular attention of the Officers of the corps.

It is true that in the British Service not only do all permanent

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works of fortification rest with the Engineers, but the execution also of all temporary works necessary for the service of the Artillery in case of actual siege, both in the attack and defence, such as opening and repairing embrasures, preparing and laying platforms, constructing expense magazines, erecting traverses in the batteries, and, in the attack, the entire construction of the batteries, with their magazines and communications; although in the armies of the great military states of the continent these duties are held to belong to the Artillery, who invariably perform them without calling in the aid of the Engineers.

Nevertheless, the good of the Service will be promoted if the Artillery assure themselves by careful examination that every detail of the works connected with their branch of the service is properly attended to, drawing the attention of the Engineers to all such points as require amelioration.

It is necessary, particularly with regard to old works, to see that the parapets are of proper height, never less than 7 feet 6 inches, and of the thickness requisite to resist the fire to which they will probably be exposed. That where they are of stone or brick the best possible means are provided for preventing casualties by splinters.

It is proper to ascertain that the platforms are long enough, and laid at a proper slope to keep the recoil within reasonable bounds. It may appear superfluous to look to this point, but it will be seen, on reference to vol. viii., page 8, of the Professional Papers of the Royal Engineers, that at Vido, Corfu, in the year 1842, a 24-pounder, when fired, recoiled entirely over the platform, and the carriage was broken. At South Sea Castle, Portsmouth, in 1845, the 32-pounder, of 56 cwt., on a garrison carriage (wood), recoiled 19 feet 6 inches on the continuous stone platform of the terre plein of the Castle, when fired with the service charge, and it was deemed proper to place sand-bags at a few feet in rear of the hind trucks of the 24-pounders to check the recoil, and so to prevent the guns from going over into the court-yard of the Castle, as they had not so much space to the rear as the 32-pounders.

Care must be taken that the banquettes are cut away sufficiently to give the men room to get well under cover, and to work the gun conveniently. Should an attack be imminent, the Artillery should see that their batteries are provided with secure and convenient expense magazines, to contain ammunition for one day's firing; that proper traverses are erected for shelter against shells; that all ramps and communications for artillery are as secure as circumstances permit. They should take especial care that all the

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large powder-magazines are rendered as secure as possible from bombardment, and all the more valuable Artillery stores are put under the best possible cover.

In fine, every arrangement of every department which bears immediately on the Artillery service deserves attention, in order that any deficiency may be pointed out in time, as, in case of failure, the excuse that it was occasioned by the fault of some other branch of the service is ungracious to make, and will never be well received. It is to be observed, in conclusion, that the object has not been to enter fully into details, which can be found elsewhere, but rather to dwell on the general considerations which mark the armament of fortresses and permanently fortified posts, as duties involving important military questions, which merit the serious study of Officers at a time when the defence of the country so much awakens the solicitude of Her Majesty's Government.

(Signed) E. N. WILFORD,
Captain, Royal Artillery.

Note on Wall-Pieces and Rockets.

As, with regard to our armaments, no exclusive means should be depended on, but all possible resources called into action, it would be well at this time to consider whether an improved wall-piece should not be introduced into the service, and provided in due proportions for our various garrisons.

There can be no doubt that a certain number of such arms would be most useful in the hands of men selected from among the best shots of the Infantry.

Although Congreve or war rockets can be regarded as but an accessary to cannon, and are subject to the great disadvantage of being very perishable in store, there are situations in which they would be useful: such as where ordnance cannot be conveyed or served, and also where, contrary to all military principles, houses and other cover have been suffered to arise within a short range of the works, which is unfortunately the case within some of the most important defences in England.

E. N. W.

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ıs were laid at differet, which was called No. 1 Platform; at 15 feet, called
ıe 10, from Point B from Point Blank to 1½° inclusive was from No. 2, and

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No. 16.—*Field Powder-Magazines.*

Taken from the Manuscript of the late Col. WILLIAMSON, R.A.

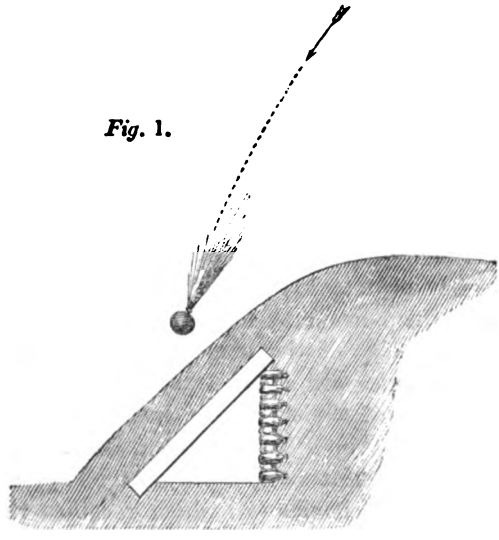
LEAN-TO, OR TRIANGULAR FIELD POWDER-MAGAZINE.

The field powder-magazines used in the sieges carried on by the British army during the late wars, were generally formed by laying stout timbers, which were usually termed "splinter-proof timbers," at an angle of 45°, sloping towards the fortress, against an earthen parapet, revetted internally, so as to inclose a space of which the section is nearly a right-angled triangle, fig. 1.

This form, called a lean-to, in reference to a technical term in carpentry, is by no means convenient for stowage, but it was adopted as being well calculated to resist the effect of the enemy's shells, which, by descending rather obliquely, and sometimes probably at a slope nearly approximating to that of the leaning timbers of the magazine, are less likely to break through it than if those timbers were laid in any other manner.

Fig. 1, for example, represents a shell falling upon the slope of a magazine of this description, in the manner supposed, which evidently could do little or no injury to the magazine.

Fig. 1.



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The details of the construction about to be described apply only to the system adopted at Chatham, for the instruction of the Royal Sappers and Miners, without reference to the field powder-magazines made on service in the late wars; of which there are no correct descriptions, and of which, in all probability, very few were alike.

The body of the magazine is 15 feet long, 6 feet 6 inches wide at bottom, and 6 feet 6 inches high; all these dimensions being in the clear. Its internal profile, therefore, is an isosceles right-angled triangle, fig. 1.

The above length is increased to 18 feet, to allow room for a passage leading perpendicularly from one end of the body of the magazine towards the rear, which passage is 4 feet 6 inches high, and 2 feet 6 inches wide in the clear, between the rectangular frames which support the roof of this part of the magazine, figs. 4, 5, 7.

The magazine is surrounded on all sides, excepting in front, by a trench of communication, which thus forms three sides of a rectangle parallel to the rear and ends of the body of the magazine, fig. 8.

The passage or entrance into the magazine before mentioned opens from the rear or centre line of the above angular trench, and the ends of the trench afford two communications from the magazine towards the parapet of the battery or other work behind which it may be situated.

Description of the Frame-work of the Magazine.

The body of the magazine has its sloping side covered with timbers, as before mentioned, and its perpendicular side revetted by planks below, and by fascines above the level of the natural ground. These revetting materials are retained by upright stanchions, placed at intervals of rather less than 4 feet apart, which are supported by struts, or oblique pieces butting against them, so that each pair, consisting of a stanchion and its strut, forms a kind of frame, fig. 2. The magazine timbers a-line with the struts, and are placed in the intervals between them.

In order to arrange the above frames more regularly, two parallel sleepers or ground-sills, *a* and *b*, figs. 2 and 5, each 15 feet 6 inches long, and 3 inches deep, are sunk longitudinally along the two sides of the bottom of the body of the magazine; to which sleepers the lower ends of the frames are fitted transversely; the sleeper (*a*) which receives the feet of the stanchions has mortices for that purpose 4 inches long by 1½ inch wide in plan, and 1½ inch deep, and each stanchion is formed at bottom with a tenon of corresponding dimensions. The other sleeper (*b*), which receives the lower end of the strut, has notches on its upper surface, each half an inch in

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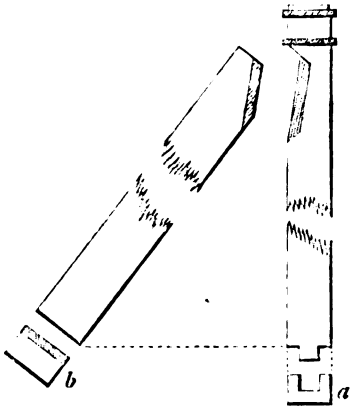
depth and 4 inches in width, extending transversely across its whole breadth, and this sleeper is laid at an angle of 45°; the former sleeper is 4½ inches, and the latter seven inches wide. The stanchions are joggled 6 inches from the top to the depth of about 1½ inch, for the head of the strut to butt against, besides which, they are mortised to the same depth, making 3 inches in all, to receive a tenon formed at the head of each strut, and parallel to the oblique side of the joint; the top of the stanchion is strengthened by a couple of hoops of iron, which may be secured by rivets or nails.

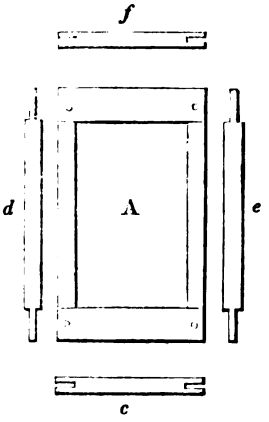
Fig. 2 represents all the joints of this frame-work according to a transverse section of the body of the magazine. Two sleepers, one (*a*) mortised, the other (*b*) notched, are shown in the section, below the parts that are to fit into them.

Fig. 2.



Frame-work of the Body of the Magazine.

Fig. 3.



Frame-work of the Entrance to the Magazine.

The frames for the passage or entrance are in 4 pieces—viz. 1. Groundsill (*c*), 3 inches deep by 5 inches wide. 2. Stanchions (*d e*), 5 inches square; and 1 capsill (*f*), 5 inches wide by 8 inches in depth, fig. 3. As they require more solidity than common mine frames, it was deemed expedient to frame them together permanently in such a manner as to leave the clear space (A) of 4 feet 6 inches high by 2 feet 6 inches wide, as before mentioned.

The pieces are put together like a door-frame in common joinery; the capsill and groundsill are each mortised through their whole depths, to receive their tenons at top and bottom of the stanchions: these mortises are open at the extreme ends.

Fig. 3 represents the whole frame pinned together, and each piece separate.

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The pieces used at Chatham for the splinter-proof timbers are 9 inches in depth, and of the average width of 6 inches; but on service it might often be necessary to cut down trees, for the purpose of forming these timbers; and in this case unnecessary labour should be avoided, by choosing any scantling of sufficient strength that may appear most convenient, without squaring all the sides. If timbers of 6 inches or upwards, of average width, cannot be procured, a greater number of planks set on edge will answer the same purpose.

For lining the magazine, 1¼-inch planks may be used for the lower part of the upright side, and of the ends of the body of the magazine, as well as the passage: these planks may either be cut into short lengths of about 4½ feet, like the sheeting-planks of mines, or they may be of greater lengths, and consequently in fewer pieces, which perhaps will be more convenient, but in this last case they must be cut to several lengths, to suit the form of the magazine, and they must be secured at the ends by bolts or hoops, to prevent them from splitting.

The fascines used for the upper part, above the natural level of the ground, ought to be cut to suit the extent of the work thus proposed to be revetted.

DETAIL OF MATERIALS.

Frame-work for the Body of Magazine.

5 stanchions, each 7 feet 10 inches long, and 4 by 4½ inches scantling.

1 groundsill for the stanchions, 15 feet 6 inches long and 3 by 4½ inches scantling.

5 struts, each 9 feet 10 inches long, and 4 by 7 inches scantling.

1 groundsill for the struts, 15 feet 6 inches long and 3 by 7 inches scantling.

For the Passage.

4 frames 5 feet 6 inches high, and 3 feet 4 inches wide from out to out.

To line the sunken part of the Magazine.

45 sheeting-planks, about 4 feet 6 inches long, 1 foot wide, and 1½ inch thick.

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To cover the sloping side, and extreme end of the Body, and of the Passage.

26 splinter proofs, of the average width of 6 inches, 9 inches deep, and 10 feet long, for the sloping side.

9 long splinter-proof timbers, of the same scantling, but 13 feet 6 inches long, for the passage, &c.

Also 4 fascines, to line the upper part of the upright side of the body, and 200 superficial feet of tarpaulin to lay over the splinter-proof timbers.

Rules for tracing a triangular Field Powder-Magazine.

The body of the magazine, which must be about 35 feet in rear of the parapet, if placed behind a battery, is traced 19 feet long by 8 feet wide in the clear, which first dimension is laid out parallel to the face of the battery; parallel to the rear and ends of the rectangle thus traced, three lines are traced, as it were, enclosing it on three sides, at the distance of 4 feet in rear, and of 12 feet from each end, fig. 4.

The two returns or perpendiculars of this second tracing are each made 24 feet long. The passage is traced by producing one end of the body of the magazine, toward the rear, which produced line determines one side of the passage; the other is traced parallel to the former, at the distances of 3 feet 7 inches. Fig. 4 represents this very simple tracing.

Number of Workmen, Tools, &c., necessary.

Fifteen is the greatest number of men that can be employed at the commencement of the work, but they may be increased to 20 after the first relief in easy soil, but not till the second relief in difficult soil.

Tools and Implements.

15 Pickaxes	1 Tracing line
15 Shovels	2 Six-feet rods
4 Rammers	Half a bundle of
1 Field-level	Pickets (12 in number).

Fig. 4.

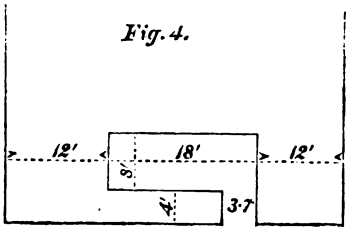

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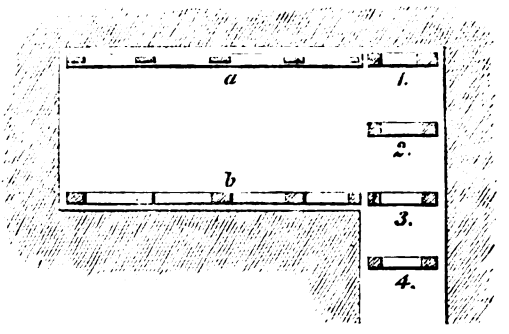
Fig. 5.



Execution of the Work.

The body of the magazine and passage will be cut 4 feet deep, which must be done with all expedition, in order that no time may be lost in placing the frame-work, which is the next operation.

The trench or trenches of communication in the rear and sides of the magazine are commenced at the same time, and must be cut 4 feet deep in rear, but towards the extreme ends, or front part of the sides, the depth must be diminished, as it will be necessary to finish them eventually in the form of ramps leading from the magazine to the battery, figs. 6, 7, 8.

In preparing to place the frame-work of the body of the magazine, the two sleepers for receiving the stanchions and struts are laid parallel to each other, at the clear distance of 6 feet 6 inches apart, in grooves properly prepared, the former being laid horizontally, and the latter at an angle of 45°, as was before mentioned. These occupy about 15 feet of the length of the excavation of the body of the magazine, the rest of which belongs to the passage, fig. 5.

When the two sleepers are laid, the stanchions and struts must be connected with each other, and fitted to their respective sleepers by pairs, as soon as possible, and the stanchions secured by wedges, or otherwise, to keep them steady for the present; the four passage-frames are then placed, one in the direction of the stanchion sleeper produced, the other parallel to it, at the distance of about 11 feet to the rear; that is, a little in front of the alinement marked for the front of the rear trench; the other two are then set up at equidistant intervals between these two.

This arrangement is represented in fig. 5, in which *a b* represent the two sleepers, showing the mortises and notches for the stanchions and struts of the frame-work of the body of the magazine, whilst the figs. 1, 2, 3, 4, show the position of the passage-frames.

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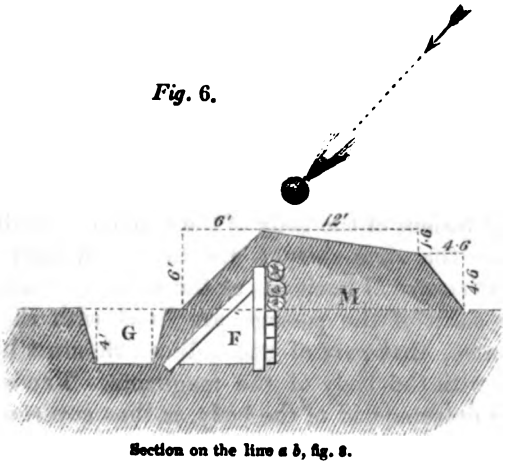
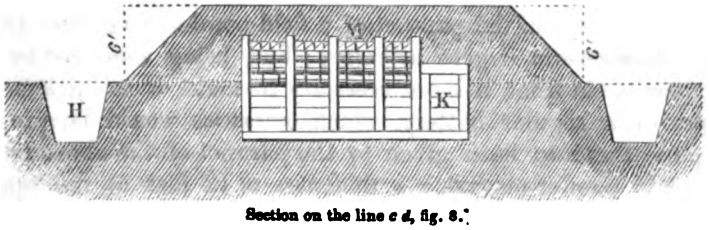
Fig. 6.



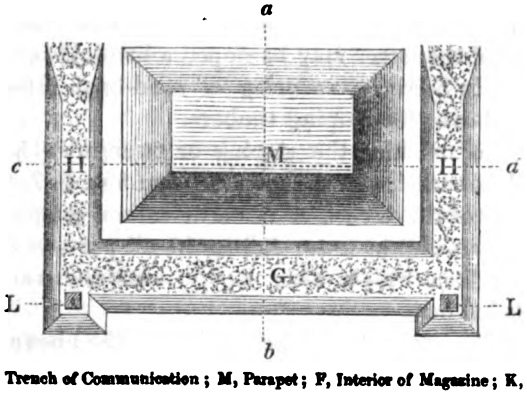
Section on the line *a b*, fig. 8.

Fig. 7.



Section on the line *c d*, fig. 8.

Fig. 8.



H and G, Trench of Communication; M, Parapet; F, Interior of Magazine; K, Entrance.

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The sheeting-planks are then introduced between the stanchions of the body of the magazine, and the vertical excavation adjacent, until the whole of the sunken part of the magazine is lined with wood-work on that side; after which, the upper part may be revetted by about three courses of fascines; the sheeting and fascines together being so arranged as just to cover a space of about 6½ feet in height from the sole of the excavation upwards.

The splinter-proof timbers are then laid in the intervals between the triangular frames of the body of the magazine, with the front of each resting on the strut-sleeper, and the top of each lying against the uppermost course of fascines; at the same time the extreme end and the two sides of the passage are lined with sheeting-planks, except, of course, that part of one side which must be left open to communicate with the body of the magazine. The whole passage, including the extreme end of the body, is then covered by splinter-proof timbers, laid horizontally over all the capsills, which being done, the whole of the timbers must be covered by tarpaulins.

Dimensions for the finished Parapet of the Magazine.

The dimensions of the parapet of a field powder-magazine are, of course, to a certain degree arbitrary; but, being sheltered by another parapet in front, it is not necessary to make it so thick as the parapet of a regular battery, which otherwise would be proper. There has therefore been given to the parapet of the above triangular field powder-magazine a thickness of 12 feet at the top, an interior height of 6 feet, and an exterior height of 4 feet 6 inches, fig. 6. The base of each of the end-slopes is laid out at an angle of 45°, the interior slope, of course, regulated by the splinter-proof timbers which cover the body of the magazine. A small berm, of from 1 to 2 feet, according to the nature of the soil, may be left between the base of the parapet and the sides of the trench of communication; and the latter may be sloped a little, if necessary.

In the sieges in Spain, a covering of sand-bags filled with earth was usually laid over the sloping timbers.

The method of finishing the sloping or triangular field powder-magazine will be sufficiently understood from figs. 6, 7, 8.

At the angles of the trench of communication, cesspools (L L) are made, into which the rain-water falling in all parts of the trench is conducted, and from which, after heavy rains, the water must be occasionally baled out.

At the time the parapet shall be finished to the above dimensions, the trenches of communication, of which the extreme depth nowhere

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exceeds 4 feet, will necessarily have been cut wide enough to admit of two men passing each other throughout their whole extent.

The parapet that has been described can scarcely be considered too strong; for though the magazine may be deemed perfectly bomb-proof against shells falling upon its sloping roof, there would be little resistance against a shell falling immediately in front of the top of the sloping timbers, and just beyond the vertex of the triangle on the perpendicular side of it, fig. 6, if the parapet were not raised to the height of at least 6 feet in that part, as shown in the transverse section, which allows a mass of 3½ feet of earth above the said vertex. The extreme ends of the body of the magazine would also be too much exposed if the length of the parapet which covers the roof were rendered less than about 40 feet at the base, and 28 feet at the top, as shown in figs. 7, 8.

The weakest point of the magazine, as it now stands, may be considered its risk from the effects of a shell falling into the trench in rear, and bursting exactly opposite to the entrance; but this would be a rare contingency.

The above magazines are good when finished, and quite as safe as can reasonably be required; for it must be recollected that nothing is absolutely safe in war.

In the whole of the British sieges during the Peninsular war, there is only one instance of a field powder-magazine having been blown up; which, however, was not precisely of the same description, as it was framed by timbers resting against the gorge revetment of a captured work, with its ends not so well protected as in the above construction.

A triangular field powder-magazine of the above description can contain 48 barrels of powder; the first or lowest course to consist of three rows of 8 barrels each, each row placed end to end longitudinally on the floor of the magazine, and as close to the sloping side as possible, and wedged on the other side to prevent them from rolling; the second course to consist of two rows of 8 barrels each, and the third course to consist of one row only, also of 8 barrels: the whole quantity of powder contained in them is 4320 lbs., or 540 rounds for a 24-pounder breaching-battery.

As it was before observed, these barrels are to be placed longitudinally, or so that the extreme length of the barrels shall agree with that of the body of the magazine, of which they will fill 14 feet in length, leaving at the same time a sufficiently convenient passage along the whole of the perpendicular side of the magazine, from one end to the other.

The ammunition in the boxes is always in cartridges, but the

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extreme weight of the powder is limited to 80 lbs. for each box; hence one of these boxes will hold 10 rounds for a 24-pounder employed in breaching.

The most advantageous method of stowing them, so as to leave a passage along the upright side of the body of the magazine, is, for the lower course, to place two rows of boxes transversely—laying them on their broadest sides to take up less height, and over these, to place one row transversely in the second course, setting them on their narrowest side; and one row longitudinally, and also on their narrowest side for the third course. By this arrangement, there will be 20 boxes in the first course, 15 boxes in the second, and 8 boxes in the third, making 43 boxes in all; so that the magazine will hold 3440 lbs. of powder, or 430 rounds for a 24-pounder breaching-battery. Of the boxes thus stowed, 25 may be opened, and the cartridges taken out without displacing any of the others; one row only of the lower course cannot be got at until all the other boxes shall be removed.

RECTANGULAR OR FLAT-ROOFED FIELD POWDER-MAGAZINE.

The chief objection to the triangular magazine being the very large parapet required in consequence of the vertex of the triangle necessarily rising to a great height, in order to afford space for stowage in that inconvenient figure, it occurred that, by adopting the rectangular section, a much smaller excavation would afford equal room for stowage, and that much less height, and consequently a much smaller parapet, would answer the purpose.

After some experimental magazines of this description had been made at Chatham, the following dimensions were fixed upon:—

The rectangle for the body of the magazine to be 12 feet 3 inches long by 6 feet 3 inches wide, and to have a passage leading from one end at right angles towards the rear, as in the former magazine, and also to be surrounded on three sides by a trench of communication, but of much less extent, and consequently less labour: fig. 2.

The frames for the body of the magazine are four in number, each 4 feet 9 inches high by 4 feet 4 inches wide from out to out, and each frame has one groundsill 3 inches deep and 5 inches wide; 2 stanchions 5 inches square, and 1 capsill 7 inches deep and 5 inches wide, put together so as to make up the extreme dimensions before specified: fig. 4.

The entrance or passage-frames also are four in number, and measure 4 feet 9 inches high and 3 feet wide from out to out, and have

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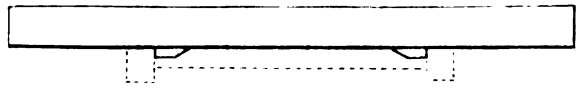
each 1 groundsill and 2 stanchions of the same scantling as those of the body-frames just described; and 1 capsill 8 inches deep and 5 inches wide, which is therefore 1 inch deeper than the former; both the body-frames and the passage-frames are framed and put together precisely in the same manner as the passage-frames of the triangular magazine before described.

For lining the magazine, 1½-inch planks may be used of different lengths, to suit the form of the magazine, and its passage, all the sides of which must be lined, as in the triangular magazine, by introducing the sheeting horizontally and on edge between the backs of the stanchions of the frames and the excavated earth.

The splinter-proof timbers may be of the same scantling as those for the triangular magazine, namely, 6 inches in average width, and not less than 9 inches in depth, and likewise of two different lengths, 10 feet for the body of the magazine, and 13 feet 6 inches for the extreme end and passage; four of the short splinter-proofs must be cleated on their lower sides in the manner represented in fig. 1, to prevent the body-frames from collapsing at top in consequence of the pressure of earth in loose soil.

Fig. 1.



The cleats should be firmly fixed at the extreme distance of 5 feet 2 inches apart, which determines the distance in the clear between the capsills of the opposite body-frames. The positions of the capsills are shown by the two small dotted rectangles in the figure.

Detail of Materials.

For the Body and Passage:—

Four body-frames, each 4 feet 9 inches high and 4 feet 4 inches wide from out to out.

Four passage-frames, 4 feet 9 inches high and 3 feet wide from out to out.

To line the Magazine:—

Sheeting-planks, 1½-inch thick and 1 foot wide.

8 of 12 feet
4 of 9 „
8 of 6 „
} long.

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To cover the Body and Passage :—

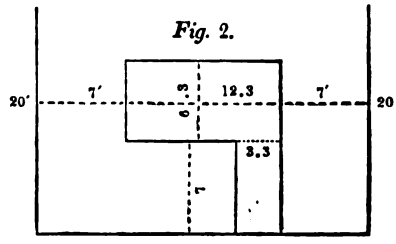
Splinter-proof timbers, 6 inches in average width and 9 inches deep.
19 of 10 feet long for the body.
7 of 13 feet 6 inches for the passage.

Number of Workmen, Tools, and Implements required.

10 Men	1 Field level
10 Pickaxes	1 Tracing line
10 Shovels	2 Six-feet rods
2 Rammers	Half a bundle of Pickets
2 Push picks	(12 in number).

The rectangular magazine is traced at least 30 feet in rear of the parapet, and, of course, opposite to a merlon in a gun-battery in a similar manner to the triangular magazine, only with different dimensions, as shown in fig. 2.

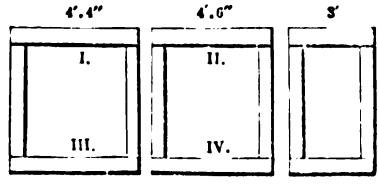
Fig. 2.



Fixing the Frame-work.

As soon as the body and passage shall have been excavated to the full depth of 4 feet, the respective frames belonging to each will be placed by sinking the groundsills in grooves cut for the purpose, about 3 inches deeper than the general level of the previous excavation. Two body-frames and one passage-frame will then be set up along each side of the body of the magazine, in the same continued alinement, and at intervals of about 2 inches apart, so as to occupy the extreme length of 12 feet, as represented in elevation in fig. 3.

Fig. 3.



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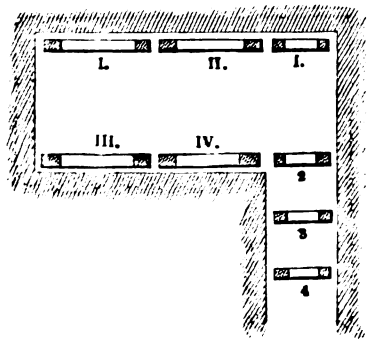
In arranging two parallel lines of frames in this manner, the opposite groundsills must be placed the distance of 6 feet from out to out, and may be prevented from falling in by placing cleated planks over the capsills of each opposite pair, until the cleated splinter-proof timbers are ready to be placed; the two remaining passage-frames will then be set up in the passage in rear of the former, and parallel to them, at clear intervals of 2 feet apart. The whole of the frames will thus be placed in the manner shown in fig. 4, in which the four body-frames are marked by the Roman numerals I., II., III., IV., whilst the four passage-frames are marked by the numeral figures 1, 2, 3, 4.

Fig. 4.



The sheeting-planks, of three different lengths, to suit the several sides of the excavation, must then be introduced in the intervals between the stanchions of the frames and the earth which is to be supported; in which operation, as these planks are used in the same manner as the side sheeting in the galleries of mines, the miner's tool called the push-pick, shaped like a small pointed gardener's spud, is used for clearing away earth, if necessary.

Four cleated splinter-proof timbers must next be laid transversely across the capsills of the two opposite pairs of body-frames, and near to their ends, introducing the cleats between the two lines of capsills, in the proper position, as before explained; the cleated planks that were temporarily used in the same manner will be removed, and may be placed as sheeting planks for the upper part of the short sides of the excavation. This being done, the earth must be made good about the frames and sheeting on all sides, until it is raised to the same horizontal level as the tops of the frames—that is, 6 inches higher than the natural ground-level; after which, the remainder of the splinter-proof timbers must be

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laid transversely over the capsills of all the frames, the short ones over the body, the long ones over the passage, in such a manner that the ends of the whole shall aline in front with those of the cleated splinter-proofs before placed; one or two more should be laid parallel to the others, and in continuation of them on each side, upon the earth immediately beyond the extreme ends of the excavation. During the operations that have been described, the whole of the men will be required to bring up and place the wood-work.

Finishing the Parapet or Roof.

As soon as all the splinter-proofs are laid, 2 of the men will take up rammers, whilst the remaining 8 will throw the loose earth, previously excavated, over the timbers, so as to form the parapet or roof, allowing a small berm, and a slope having its base equal to its height, towards the three sides of the branch of communication. In front, the same or a greater slope may be allowed, as in the exterior slopes of batteries exposed to a direct fire. The parapet now under consideration should be raised on all sides to the height of 4 feet above the original ground-level, which must not be exceeded, excepting in the centre, where it must be raised nearly 6 inches higher; and from thence slopes will be made to each side of the rectangular top.

Figs. 5, 6, 7, are sections to illustrate the nature of a rectangular field powder-magazine, supposed to be formed according to the above rules, in rear of an elevated battery, and consequently having ramping returns. The roof or parapet thereby formed will measure in transverse section about 19 feet at the base, and 9 feet 6 inches thick at top, as shown in fig. 5.

Fig. 5 is a section taken in a line through the body of the magazine and the trench in rear, a part where the latter is 3 feet deep.

Fig. 6 is a transverse section of the magazine, taken parallel to the former section, and through the passage opposite to which the trench in rear is 4 feet deep.

Fig. 7 is a longitudinal section of the magazine at right angles to the former sections, and also through the two returns of the trench of communication. In this description the parapet measures about 23 feet in length at the base, and 16 feet at the top.

In order to keep the magazine dry, a cesspool must be formed somewhere in the rear of the deepest part of the trench of communication, that is, opposite, or nearly opposite, to the entrance of the magazine, in order that the rain falling at the entrance may be led off towards the cesspool, fig. 8.

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Fig. 5.

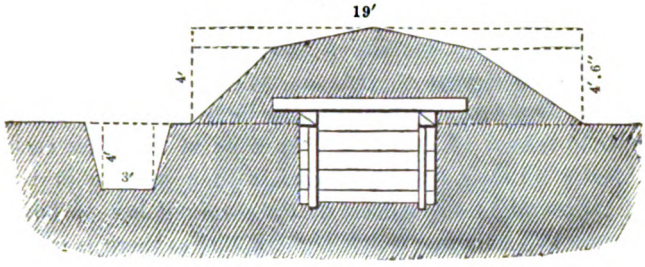


Fig. 6.

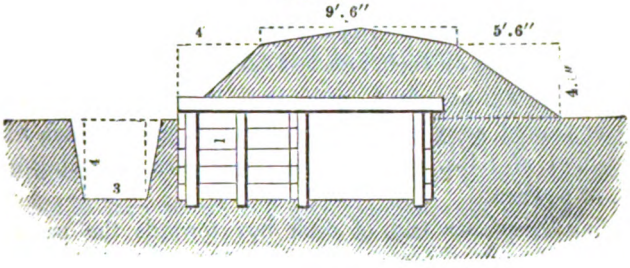
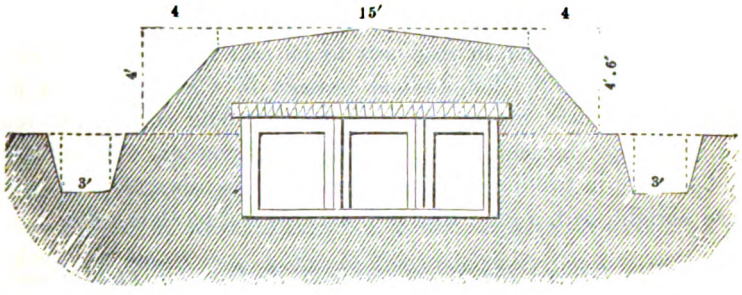


Fig. 7.



It is possible that the rectangular powder-magazine may be so situated, in reference to the parapet of the battery to which it is attached, that two returns from the trench in rear would be superfluous. In this case the width of that trench, as well as of the single return leading from it towards the battery, must be increased, in order to afford sufficient earth for the parapet of the magazine.

In stowing away powder-barrels in this magazine, they may be laid in three tiers or courses, placing two transverse rows of 6 each in the first course, two transverse rows of 5 each in the second course, and the same number in the third or upper course: this makes 32 barrels in all, containing 2880 lbs. of powder, or 360 rounds for a 24-pr. breaching gun, and at the same time leaving a passage from one end of the maga-

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zine to the other, independent of the entrance passage. By filling a part of the first of the above passages, 12 more barrels may be got in, amounting in all to 44 barrels, or 3960 lbs., or 495 rounds for a 24-pounder breaching-gun.

Ammunition Boxes may be arranged in three tiers or courses, the two first courses to consist of two transverse rows of 10 boxes each, placed upright, that is, on their narrowest sides, with a passage in the centre. The third course might also consist of the same number of boxes, if the magazine were two or three inches higher; but as there is scarcely room for another upright course without jamming, and as it does not appear expedient to make the interior height of the magazine greater than 4 feet 6 inches, let the third course of boxes consist of two transverse rows of 6 boxes each, laid flat on their broadest sides, by which means the height of the whole pile will be a fraction less than 4 feet. The number of boxes that may be stowed away in this manner is 52 in all, which will contain 520 cartridges of 8 lbs. each for a 24-pounder breaching-battery, or 4160 lbs. of powder.

By placing the proper end of each box towards the passage, all the cartridges may be taken out without disturbing a single box: indeed the ammunition-boxes themselves might be taken to the battery one or two at a time, and, when emptied, might be put aside in some convenient part of the trench, near at hand, in readiness to be sent back for a new supply. By filling a part of the longitudinal passage of the magazine, it might hold 20 boxes more, making 72 in all, which would contain 720 rounds for a 24-pounder breaching-gun, or 5760 lbs. of powder. These 20 boxes may be placed in two longitudinal courses of two rows of 4 boxes each, placed upright, with a third course of 4 boxes laid on their sides.

Comparison between the Triangular and Rectangular Field Powder-Magazines.

1st.—In regard to Stowage.

The triangular field powder-magazine holds more common powder-barrels by one-half than the rectangular field powder-magazine, but not quite so many of the new-pattern powder-boxes.

2nd.—In regard to Labour and Time.

The triangular field powder-magazine requires 15 workmen, and cannot be finished in less than 9 hours in the easiest soil, whereas the rectangular field powder-magazine may be finished by 10 men in 4 hours in the same description of soil.

The first rectangular field powder-magazines made at Chatham, for the sake of experiment, were revetted interiorly with gabions and fascines;

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and as the same materials may be substituted instead of regular frames and sheeting on service, if a scarcity of wood-work should occur, it is proper to describe the arrangement, which will not be done so much in detail as has hitherto been done; the former construction being followed, so far as the difference of the materials used will permit.

Quantity of Materials necessary.

Gabions	24
Fascines to be cut in lengths	12
Fascine pickets, bundles of	2
Splinter-proof timbers, 6 by 9 inches, 7 feet long—from 4 to	7
Splinter-proof timbers, 6 by 9 inches, 10 feet long	21
Splinter-proof timbers, 6 by 9 inches, 13 feet 6 inches long	9

The above materials will probably weigh about 68 cwt., and may be carried by 144 men,—that is, under the supposition that there shall be one man to each gabion, two men to each of the shorter splinter-proofs, and three men to each fascine and long splinter-proof timber.

The number of workmen, tools, and implements required are—

10 Men	2 Mauls
10 Pickaxes	1 Tracing-line
10 Shovels	2 Six-feet rods
2 Rammers	1 Bundle of tracing pickets (25 in number).
2 Hand-saws	

The body of the magazine and passage may agree nearly with the dimensions laid down for the former construction, after the gabions shall be placed; but as these occupy 2 feet each way, about 4 feet must be added to the length and width of the excavation for the body of the magazine, and to the width of the excavation for the passage. The former, therefore, may be made 15 feet 6 inches long, by 9 feet 6 inches wide at bottom; and all these excavations may be made to increase towards the top, by about 6 or 9 inches on each side, in order that the gabions may stand with a slope.

The angular trench of communication may be traced about 5 feet 6 inches each way, from the rear and ends of the great rectangle marked out for the body of the magazine, which, after the gabions shall be placed, will assimilate to the distance of 7 feet allowed in the former construction.

At Chatham, in making the gabion field powder-magazine now alluded to, the two angles of the trench in rear were generally rounded off, as shown in fig. 8, which also sufficiently explains the original tracing.

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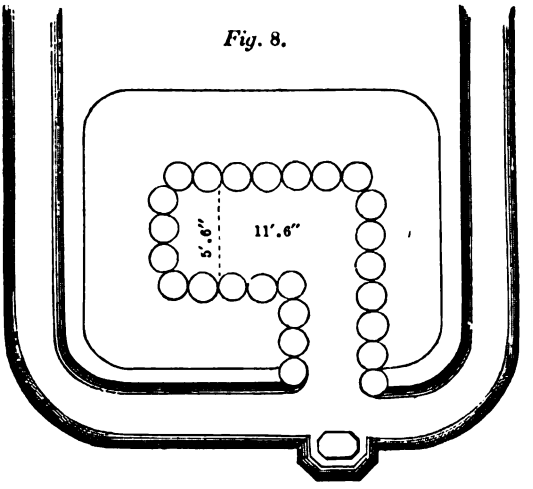
Fig. 8.



The 10 men are all employed at first as diggers,—namely, 6 in the body of the magazine, 1 in the passage, and 3 in the returns or extremities of the trench of communication. When the body and passage are excavated to the proper depth of 4 feet, they will all bring up and place the gabions, and afterwards the fascines and splinter-proof timbers.

In order to raise the interior of the magazine to the proper height of 4 feet 6 inches, and to afford a support for the splinter-proof timbers, the fascines are laid longitudinally, in two courses of 2 fascines each, and picketed down over the tops of the several lines of gabions all round, excepting only in that part of the passage which is in rear of the body of the magazine. Then one course of 2 fascines is laid over the gabions longitudinally on each side, and upon these two parallel courses of fascines, short splinter-proof timbers, not less than 4, and which need not exceed 6 or 7 in number, are placed tranversely over the passage, which they cover, at least partially. These are intended to perform the same office as the capsills of the passage-frames in the former construction,—viz., to support the long ends of the splinter-proof timbers that are afterwards to be laid over all.

After the above arrangements of covering the gabions with fascines, and the passage with short splinter-proofs, shall have been completed, the earth is made good on all sides of the body and passage nearly to the same level as the top of the fascines, and rammed; and the whole of these excavations are covered by the regular splinter-proof timbers in the usual manner, all placed at right angles to the sides of the body of the magazine; the short timbers of 10 feet in length, with their ends projecting equally

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on each side beyond the excavation, and the long timbers of 13 feet 6 inches being made to aline in front with the others.

In finishing the magazine, 2 men must be employed in ramming whilst the others act as shovellers and diggers, until the splinter-proof timbers shall be covered with earth to the extreme height of 4 feet 6 inches in the centre, and of 4 feet at each side, above the original ground level. This mass of earth is rounded at the front angles as well as in rear, the exterior slopes all round being laid out nearly at an angle of 45°. Hence, if the crests of the slopes be rounded a little at top, the roof thus formed has the appearance of a kind of dome, the base of which was shown in fig 8. The cesspool is made in rear of the entrance. For the further illustration of this construction, figs. 9, 10, 11, have been drawn.

Fig. 9 is a tranverse section taken through the body of the magazine and the trench of communication in rear, at a part where the latter is 3 feet deep.

Fig. 9.

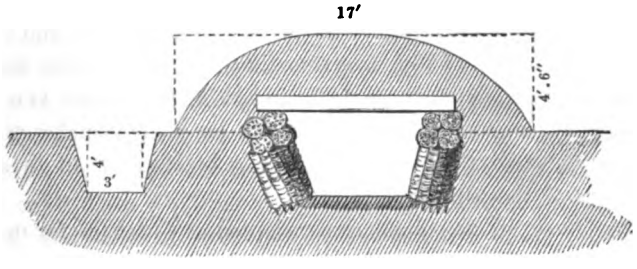

Fig. 10 is a section parallel to the former, taken through the passage, one side of which is seen in elevation, and also through the trench in rear, which at this part is 4 feet deep. The short timbers over the passage are shown in tranverse section, whilst one of the long splinter-proofs which they support appears at full length.

Fig. 10.

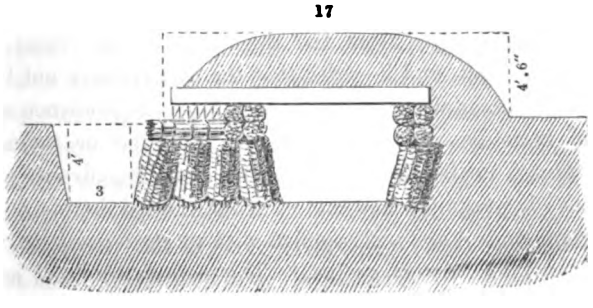

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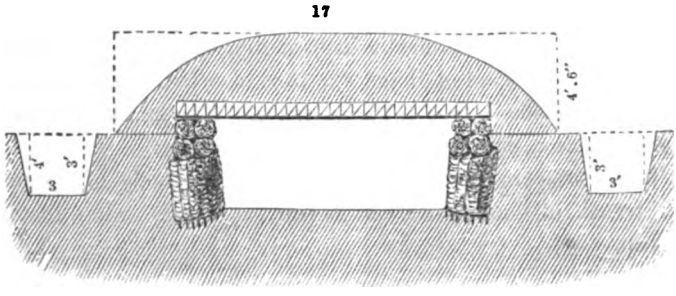
Fig. 11 is a longitudinal section taken through the body of the magazine, and also through the returns of the trench of communication on each side of it. In this figure the splinter-proof timbers of the body and passage are shown in tranverse section.

Fig. 11.



The roof or parapet represented in the foregoing sections, and measuring at the base 23 feet by 17 feet, may sometimes exceed the latter dimensions, on account of the circumstance before explained, that the two ramps of communication may sometimes require to be made trenches of uniform depth, and the earth thus obtained can only be disposed of by adding to the thickness of the parapet in front.

The foregoing are the dimensions adopted at Chatham for instruction, but the capacity of the magazines ought to be such as to contain not only the quantities of ammunition required for 24 hours' consumption for the battery, but also room to work, and as it is improper to have too great a quantity of ammunition in one place, it will be necessary, whenever the battery consists of more than four pieces, to construct two magazines; when of nine pieces three, and so on. In mortar and howitzer batteries there ought to be two magazines, one for the charging powder and the other for loading shells.

The situation of the magazines, as has been before stated, in order that they may be well covered from the direct fire of the enemy, should be behind the epaulment, and in order that the carriers may not have too far to go for the ammunition, as near the parapet as prudence may dictate, but should there be any hillock or rising ground or ravine near the battery, although further off than would be desirable, advantage should be taken of the circumstance, and the magazine formed there.

When the besieged are well supplied with mortars great precautions are required in making these magazines. The passages as well as the whole

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roof ought to be covered with strong beams and at least two layers of fascines.

Powder Magazines in Fortresses.

These magazines are of two kinds, large and small, the larger, which may properly be called powder-magazines, serving as the principal store for that article, are often placed in retired situations, while the small ones, usually styled expense magazines, serve for the daily expenditure of the garrison, and are therefore distributed in various parts near the principal works and batteries.

All powder-magazines ought to be formed of such solid materials and dimensions as to be what is called Bomb Proof.

Powder-magazines are usually provided with double doors and window-shutters made of thick materials, and covered with copper plates both inside and outside, having a number of small holes perforated through them. As an additional security to powder-magazines of any importance an enclosing wall of 10 or 11 feet high is usually built round them at the distance of about 12 feet.

In cases of siege it is usual and indeed necessary to place splinter-proofs and traverses before the doors of the principal magazines of a fortress, and the windows, especially those on the side of the country, are frequently built up or shut up with logs of timber; in this case the magazines are very dark, and, indeed, many magazines situated in the towers of old fortifications have scarcely any light at all, it is consequently necessary to make use of lanterns, they should be what are called Muscovy lanterns, and should invariably be held by a non-commissioned officer or some trusty person; the door of the lantern should never on any account be opened in the magazine, and the candles should be of wax, as when of tallow they frequently require snuffing. Splinter-proofs before the doors of magazines make them very dark, and a person upon first entering fancies himself in complete darkness, but after a very short time things are readily distinguished; the men therefore at work in the inside of the magazine ought always to remain inside, and those outside never to enter, but lay the barrels down or receive them at the door-way, besides a third party stationed at the entrance and communicating with the other two.

No iron or steel are ever permitted in the construction of powder-magazines, these metals being liable to strike fire, they are also furnished with conductors, to guard against accidents from lightning. The floors are formed of strong planks, with joists below them, which are supported by low brick walls or piers to keep them dry, and care is always taken to

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produce a proper ventilation or draught of air below the flooring to keep the magazine dry.

Formerly the gunpowder of fortresses was generally placed in towers or casemates near or under the ramparts of the main enclosure. But it being found in cases of explosion, that magazines so situated occasioned practical breaches in the body of the place, and thereby rendered the fortress untenable, a rule has been since adopted to remove the principal magazines from the vicinity of the ramparts altogether, or to place them in the centre of empty bastions, where, if any accident takes place, their destruction will not lay open the fortress to an assault.

Powder-magazines are usually divided into certain spaces called bays by wooden posts or uprights connected together at top and bottom by open frame work, figs. 1, 2.

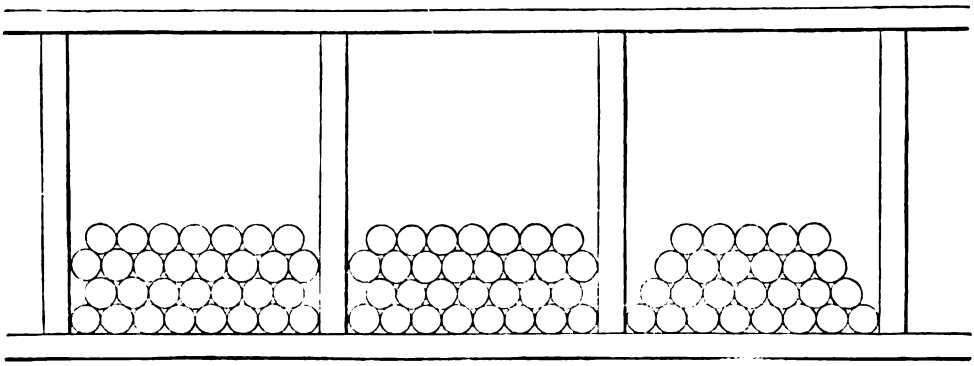

Fig. 1. Fig. 2. Fig. 3.

A bay 17 feet 9 inches long, by 5 feet 6 inches wide, and 11 feet 2 inches high, will hold 312 common barrels, each containing 90 lbs. of loose powder, piled nine high in alternate courses of twelve and eleven barrels each, placed side by side, the pile being three barrels wide, which in this direction are laid end to end; if only two barrels wide, the pile would contain only 208 barrels.

A bay of the same length and height, but about 6 inches wider, will hold 1295 quarter-barrels of musket ball cartridges, containing each 500, and piled 14 barrels high, in courses of 19 and 18 barrels, laid side by side, the pile being 5 barrels wide. When the musket-cartridges are in half-barrels, they ought not to be piled higher than powder barrels.

Passages are left between the parallel bays, and at the ends, of $2_{1}\frac{1}{2}$ feet wide.

Barrels containing gunpowder or cartridges ought never to be piled

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higher than the above mentioned height, and when so piled they require very strong uprights to resist the lateral or side pressure; indeed, when there is plenty of room, the barrels ought not to be piled higher than 8 and the quarter-barrels 12, for where barrels are piled too high those in the lower tiers always suffer from the pressure of those above, the staves and hoops, and the barrels lose their shape; the hoops when of hazle start, and the head of the barrel gets bulged, and the powder falls out.

Copper hoops, however, resist great pressure, and all barrels of gunpowder ought to be provided with them. The ball-cartridge barrels have only hazle hoops, the expenditure of which is very great, and what is worse they constantly require repairing and replacing, in doing which much time is lost.

The powder-barrels used by foreign nations are almost always hazle hooped, so that they cannot be piled so high as English barrels for the reasons above given; those which contain 200 lbs. of powder ought never to be higher than three tier, and those containing 100 lbs. four tier only.

In all powder-magazines it ought to be an invariable rule that one of the bays be empty for the sake of shifting the powder, which ought to be frequently done. The empty bay is to receive the barrels from a full bay, and this bay just emptied is to receive those of another full bay, and so on, so that the last bay emptied will remain so.

When shifting the powder the situation of the barrels must be changed, those which were in the top tier are placed in the bottom tier, and those which were in the bottom in the top, by which means they are relieved from the great pressure which was on them when they were lowest.

Should it be impossible to have a complete bay empty, there ought to be a vacancy for 10 or 20 barrels, by which means the powder can also be shifted, or should the magazine be quite full and the barrels require shifting, these must be removed on one side and stowed in the passages between the bays, a certain number of barrels so as to clear a space sufficiently large for shifting the others, and these barrels are to be stowed the very last to complete the last bay.

When in a fortress there happens to be more powder than can be stowed away in the regular magazines, casemates and sallyports are converted into magazines; they are seldom fitted up with regular bays, the barrels are stowed away upon the same principle as a pile of case shot, each tier of barrels being one fewer in number than the tier immediately below it, so that in this case a great deal of room is lost for want of regular bays (fig. 3).

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The powder magazines of a fortress are generally under charge of the store-keeper, but of course under the control of the Commanding Officer of Artillery.

Expense Magazines.

These magazines are much smaller than powder-magazines; when possible, they should be "bomb-proof," but in general they are not so. In a fortress there ought to be an expense-magazine to each bastion and battery, though this is not always the case, they generally only contain made-up ammunition, that is, cartridges for the ordnance in the bastion or battery at the rate of so many rounds per gun, to which is to be added the tubes, port-fires, &c.; sometimes the side arms and case-shot, &c., are kept there, and are usually under the care of the Artillery Officer in charge of the district; they are often made under the earth ramparts of fortifications with a cut or passage made into them in the interior slope, they ought not, however, to be made until a siege be apprehended, for as they are only temporary, and constructed of wood-work, from the mass of earth in contact with them on every side but the entrance, they are often damp and the wood soon decays.

When there is only one expense-magazine to several batteries, or when a battery consists of only two or three pieces, it is usual to have on each battery portable magazines; they are wooden boxes covered with canvas, and of such size as to be carried from place to place; they are sometimes on wheels and sometimes without, in the latter case they ought always to be placed on skidding to keep them off the ground, besides having ledges on their bottom. In these is contained a certain number of cartridges for each piece in the battery, together with tubes and port-fires, the side-arms, handspikes, &c., are in such a case placed in a small shed built against the interior slope of the epaulment to defend them from the weather.

From the small number of Artillerymen generally attached to fortresses the labour of arming the batteries on a sudden turn out is very great, and ought as much as possible to be diminished, expense and portable magazines are therefore indispensable, particularly on the sea line of maritime fortresses, on which indeed the guns are sometimes kept constantly loaded.

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No. 17.—*Military Force of France, Communicated by*

Captain Maberly, R.A.

A law passed in 1841 requires the maintenance in France at all times of a force amounting to 344,000, and not exceeding at any time a total of 500,000 fighting men.

Infantry. 100 regiments of the line and of light infantry of 3 battalions each, containing 7 companies per battalion, a grenadier company, a light company, and a depôt company inclusive. 10 battalions of infantry chasseurs or light infantry *par excellence*, each of 8 companies, two depôt companies included for battalions serving in Algeria. One regiment of Zouaves allowed to enlist natives of Algeria, each battalion comprising 9 companies inclusive of a depôt company. 3 battalions of "Africa" light infantry, each of 8 service and 2 depôt companies. 12 discipline or police companies. One foreign legion comprising 2 regiments of 3 battalions of 8 companies each.

Cavalry. 2 regiments of carbineers, 10 of cuirassiers, 12 of dragoons, 8 of lancers, 9 of hussars, each regiment consisting of 5 squadrons.

Artillery. 14 regiments, 10 of which consist of 14 batteries and 4 of 15, each regiment having its own depôt in addition. 1 regiment of pontoneers of 12 companies, 12 companies of workmen, half a company of armourers, 6 corps of park train each of 8 companies; the strength of a company on the peace establishment is 96 men and 4 officers.

Engineers. 3 regiments, each of 8 companies, *viz.* 7 of sappers and 1 of miners, besides which each regiment has 1 company of sapper leaders and 2 of artificers attached to it.

Gendarmerie. 26 legions, 1 is serving in Algeria. 1 additional legion of 4 companies of light gendarmerie is employed in Corsica; this arm consists both of horse and foot, the proportions of which cannot be correctly given. The municipal guard of Paris, horse and foot, consisting of about 1600 men, (all distinguished for good conduct or service in other corps, and providing, when mounted, their own horses, ranking amongst the finest, if not as the finest corps of troops existing), and accoutred as were the old imperial guard of Napoleon.

One fire brigade (*sapeurs pompiers*) of 5 companies.

Veterans are divided into 8 companies of non-commissioned officers, 10 of fusileers, 4 of cavalry, 13 of artillery, 1 of engineers, and 2 of gendarmerie.

General service. 1 battalion of workmen of 10 companies and a depôt, 4 brigades of wagon train, each of 4 companies and a depôt, 4 companies of labourers being also attached to each brigade.

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The reserve or dismissed men liable to be called on for further service are not included in the foregoing statement. They are reviewed twice a year. The war establishment contemplates 9 companies as the strength of an infantry battalion, depôt included, and fourth battalions to regiments where needed, also a sixth or extra squadron to the cavalry regiments. The war complement of artillery is left to the discretion of the Minister of War. Each engineer regiment would obtain a ninth company of sappers and 2 depôt companies.

The park trains and pontoneers would also form war depôts, and an addition of two extra companies would be made to each wagon brigade train.

Two regiments of mounted guides, consisting of 6 squadrons, would be added to the army upon a war footing, for staff service.

On the 1st January, 1846, after the liberation of 51,071 men of the class of 1838, the active army had an effective of 374,766 men, of which 275,188 were in the corps at home, and 99,578 composing the army in Africa. The reserve reckoned at the same period, an effective of 82,869 men (of which number 11,569 had already served), not reckoning the 80,000 men of the class of 1845, who would be at the disposal of the Government only in the course of the month of July following.

No. 18.—*Artillery of France, Communicated by*

Major Ross, R.H.A.

A royal ordonnance dated 13th Sept. 1833, founded on the report of the then minister of war (Marshal Soult), decreed the organization of the French artillery upon a new basis. By the then existing organization (5th Aug. 1829), it was composed of 11 regiments, each regiment consisting of 3 batteries horse artillery, 6 field batteries, 7 foot artillery companies, and in time of war only, a depôt.

It would appear by this, that 33 horse artillery batteries and 66 field batteries could at once be sent into the field, but the report, after enumerating various objections to the system, proposes that "*each regiment shall be composed of mountain batteries only,*" and "the only thing then would be, to give on the peace establishment, a uniform composition for all the skeleton batteries, in such manner, that on occasion requiring it, they may receive the number of men and horses appropriated to the war complement, an operation similar to what is practised when it is deemed necessary to increase the strength of a cavalry regiment." It then goes on to say, that the number of regiments must be increased, and fixes it at 14.

Each regiment to be composed of an etat-major, a supernumerary section (non-combatants, quarter-master, clerks, and artificers, &c.), not in the ranks (*peloton hors rang*), 12 batteries and a depôt, 6 chefs d'escadron, and 1 major. The 4 first regiments to have 3 of the 12 batteries horse artillery, and the remaining 10, only 2 each; 32 batteries of this nature being deemed indispensably necessary.

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The report proceeds to state "the necessity for a distinct corps, but dependant on the artillery, to provide for the duties of the parks, siege, and pontoon equipments, as well as for the transport of all the munitions of war; this wagon train (*corps du train des parcs d'artillerie*) to be a mere skeleton, but capable of great extension in case of war, and to be limited to what is strictly necessary for the instruction, as well as for *the service of the arsenals* and the *schools of artillery*, each squadron to be commanded by a superior officer, to be composed of an etat-major, a supernumerary section, 6 companies, and in time of war only, a depôt.

The report continues, "The 4032 draught horses will at once permit of being brought into the field, 336 guns and 336 wagons, drawn by 6 horses each, or 336 guns and 672 ammunition wagons, drawn by 4 horses each. Such would be the minimum of the resources of France in field artillery should war unexpectedly break out."

Peace Establishment as adopted in 1833.

	Men.			Horses.		
6 Squadrons *Wagon train.*	Officers.	N. C. off. & soldiers	Enfans de troupe.	Of officers.	Of troops. Riding.	Draught.
6 Etats-major	30	30	—	48	30	—
6 Pelotons hors rang	6	168	12	12	—	—
36 Companies	36	1,080	72	36	144	576
Total	72	1,278	84	96	174	576
14 Regiments.						
14 Etats-major	238	140	—	406	112	—
14 Pelotons hors rang	14	714	28	—	—	—
32 Batteries horse art.	128	3,072	64	128	1,536	768
136 Field batteries	544	13,056	272	544	1,360	3,264
14 Depôts	56	266	28	56	140	—
Total	980	17,248	392	1,134	3,148	4,032
General Total	1,052	18,526	476	1,230	3,322	4,608
					7,930	

In 1840 (15th Nov.), when war seemed imminent and the whole French army was increased, 32 batteries were added to the artillery force, the 4 first regiments receiving three additional, and the remaining 10, two each; 16 additional chefs d'escadron were named, and 12 additional companies of wagon train formed, the regiment of pontoneers was at the same time increased, and placed on a better footing as below. [19th Nov. 1840].

	War establishment.		Peace establishment.	
	Men.	Horses.	Men.	Horses.
Officers	66	156	61	—
N. C. Officers and soldiers	1551	—	873	—
Enfans de troupe	13	—	13	—
Total	1,630	156	947	—

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Peace Establishment, Law of 1841.

	Officers.	N. C. Off. & men.	Enfans de Troupe.
14 Regiments (4 of 15 batteries each, and 10 of 14), with a depôt to each	1,124	20,320	456
6 Squadrons of wagon or park train, each consisting of a staff and 8 companies	84	1,638	108
6 Companies foot artillery veterans	24	1,200	—
1 Regiment pontoneers	61	873	13
12 Companies artillery artificers	48	840	24
1 Company armourers	4	100	2
Total	1,345	24,971	603

Establishment of Horses.

	Men.			Horses.		
	Officers.	N. C. Off. & soldiers.	Enfans de troupe.	Officers.	Riding.	Draught.
14 Regiments	1,124	20,320	456	1,294	3,468	4,800
6 Squadrons wagon train	84	1,638	108	108	222	768
Total	1,208	21,958	564	1,402	3,690	5,568

The 4,800 draught horses attached to the 14 regiments, give 400 guns and 400 wagons, drawn by 6 horses each, or 400 guns and 800 wagons drawn by 4 horses each.

Such was the peace establishment according to the law of 1841, but by the official return (Aug. 1846), it would appear that a considerable increase must have occurred, as the number of non-commissioned officers and men then amounted to 29,293.

Officers, N. C. Officers, and Soldiers of Batteries.

	Horse artillery.				Field batteries.				Foot artill.
	War estab.		Peace estab.		War estab.		Peace estab.		
	Men	Horses	Men	Horses	Men	Horses	Men	Horses	Men
1st captain	1	3	1	2	1	3	1	2	1
2nd captain	1	3	1	2	1	3	1	2	1
1st lieutenant	1	2	1	1	1	2	1	1	1
2nd lieutenant	1	2	1	1	1	2	1	1	1
Officers	4	10	4	6	4	10	4	6	4
Adjutant	1	1	—	—	1	1	—	—	—
Serjeant-major	1	1	1	1	1	1	1	1	1
Serjeants	8	8	6	6	8	8	6	3	8
Fourrier (pay serjeant)	2	2	1	1	2	2	1	1	1
Brigadiers (corporals)	12	12	6	6	12	6	6	3	12
Artificiers (fireworkers)	6	6	6	—	6	—	6	—	6
Gunners 1st class	28	66	16	32	24	—	16	—	66
Gunners 2nd class	54		24		36	—	24	—	100
Drivers 1st class	40	156	10	24	44	180	10	24	—
Drivers 2nd class	58		16		66		16		
Artificers in wood and iron	4	—	4	—	4	—	4	—	4
Farriers	3	3	2	—	3	3	2	—	—
Collar Makers	2	—	1	—	2	—	1	—	—
Trumpeters	3	3	3	2	3	3	3	2	2
Grand Total	226	268	100	78	216	214	100	40	204
Enfans de Troupe	2	—	2	—	2	—	2	—	2

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No. 19.—*Remarks on Military Carriages, and Gun Metal.*

By Captain W. Manley Dixon, R.A.

In the Construction of Carriages which are to support a certain load and to travel over rough ground, it is only necessary to have particular regard to the ordinary shocks and jars which the whole system has to sustain and which is common to all wheel carriages; but, when a carriage has to bear the firing of a gun placed upon it, a totally new description of forces has to be taken into careful consideration, and the strength, as well as solidity, must depend principally upon the following data which are given by a foreign writer, (Timmerhans), on Artillery.

"1st.—The whole amount of force due to the explosion of the charge impressed upon the system, a force which is itself determined by the weight of the projectile and the charge, and by their relation, by the ordinary elevation of the Piece, the Windage, &c.

"2nd.—The weight of the Gun or Piece of Ordnance.

"3rd.—The construction of the Piece, above all, the emplacement of the Trunnions.

"4th.—The construction of the Carriage, principally the inclination of the trail with the ground, the relative position of the Trunnion-holes and the Axle-tree, the situation of the centre of gravity of the system, the dimensions of the several parts of the Carriage in a horizontal and vertical direction, and the more or less judicious application of the iron work to strengthen the various parts, &c."

The explosion of a charge of Gunpowder acts in every direction, with a force proportional to the weight of the projectile and the charge, hence arises the recoil or backward movement of a Gun.

Now, supposing the Gun to be so situated as not to be restrained by any force acting against its trunnions, or in other words, supposing the Gun to be at liberty to recoil to its full extent, which would be the measure of the force impressed upon it, then the difference between it, and the recoil upon a Gun Carriage, would be the measure of the force, checked by the Carriage and therefore expended on some part of itself.

The direction of the recoil of a Gun would naturally be in the line of its axis; several causes, however, operate to produce a different motion to the Gun, so that the force of the explosion of the charge does not act principally in that line.

The principal causes which alter the direction of the recoil of a Gun, are—

1st.—The mode by which the Piece is supported.

2nd.—The re-action of the elastic fluid on the side of the bore opposite to the vent, which, following the law of all effluent fluids, impresses an

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amount of force on the gun opposite to the vent, equal to that with which the fluid escapes through the vent.

A Gun is supported by its Trunnions and by the Elevating Screw; the trunnions are placed with their axis rather below the axis of the gun, and consequently, the breech of the gun must have a tendency to rotate round the axis of the trunnions; the greater or less tendency, in different guns, arises a great deal from the distance the axis of the trunnions is situated below that of the gun, together with the preponderance which is thus given to the piece, and the distance of the trunnions from the base ring.

The tendency to rotate is checked, or impressed rather, on the head of the elevating screw which transmits the shock to the trail, giving to it thereby a forcible pressure downwards.

This pressure causes the end of the trail to sink into the ground a certain depth, (proportional to the nature of soil it is resting on), and immediately to be forced up, the height to which the end of the trail "jumps" being due conjointly to the force it was pressed downwards with and the elasticity of the soil.

This force is transmitted through the length of the Trail to the Axle-tree and Bed, and is the cause, as French writers assert, of some natures of Ordnance so frequently breaking their Axle-trees.

It is a fact, proved by all experience, that short and light Pieces cause a greater strain to their Carriages and act peculiarly in the way above stated, and all Foreign writers state the difficulty of preserving their Carriages from the destructive action of these forces; a certain length of Piece and preponderance seems practically necessary to ensure the safety of the Carriage upon which, in the Field, so much depends.

It would seem that the only principles upon which Carriages can be constructed for Pieces of Ordnance, are a knowledge derived from accurate experiments of the dynamical effects of each nature and construction of Ordnance, and the limits within which such effects may with safety be disregarded.

From the above short summary of the nature of the action of a gun on its carriage, with the circumstances under which that action will prove excessive, the natural deduction is, that where mobility, strength, and durability, are to be combined in a gun and its carriage, the two must be considered together as a whole, and that construction of gun adopted, which will not injure its carriage within a reasonable time, and which will present the greatest average amount of advantages.

A gun, viewed in the abstract, cannot be too light (within the limits of sufficient strength), to bring into the field, and its construction may well be governed by adopting that form which will give the greatest strength of material, in the part where it is most needed, but if this gun is to have a carriage, and this latter is to accompany the gun under all circumstances, and its preservation to be as much considered as that of the piece, then it becomes an imperious necessity to sacrifice some of those exclusive advant-

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ages possessed by a light gun, when it is found that they militate against the safety of the carriage, and to arrive at that point where the construction and weight of the gun shall tend to preserve the carriage, and that both together shall possess sufficient mobility.

Gun Metal. (TIMMERHANS.)

The material of which Guns are made should have the following properties,—hardness, elasticity, and tenacity. These qualities are rarely found united in one material in a sufficiently high degree, to allow of its being used exclusively for all natures of Ordnance and for all Services.

The material should be hard, so as not to yield too easily to the action of the ball when passing out of the bore; tenacious, so as to resist the explosive power of the Gunpowder and not to burst; and lastly, elastic, so that the particles of the material of which the Gun is composed should, after the vibration caused by the discharge, return to their original position.

Forged or wrought iron possesses the above qualities in a very high degree, and it is for this reason that it is employed for the manufacture of Small Arms; it is not so hard as cast iron, but resists the action of leaden balls very well.

All Ordnance, strictly so called, are made of Cast Iron, or Brass, or more properly Bronze.

Cast iron formerly was only used for those pieces intended for the armament of Vessels of War; the great number of Guns which were required for this purpose, and the expense of Brass Guns, rendering this necessary; the Field Guns were generally of Bronze, because those of Iron frequently burst.

Of late a superior method of preparing Cast Iron has been adopted, by which a portion of the carbon has been taken from it, together with other foreign matters, and thus its tenacity has been increased; a too rapid cooling of the Piece has been also prevented; it results from this that the tenacity of Iron Guns at present is very satisfactory; and, as they are considerably harder than Bronze Guns, they are much less liable to internal injury.

Iron being also a slower conductor of heat than Bronze, the expansion of the gas, resulting from the fired Gunpowder, is less diminished; this would add to the effect on the projectile, and cause greater precision to be attainable from Iron Guns.

The only fault which can, at present, attach to Cast Iron is its small elasticity, and above all its unequal resistance, from which it happens that some Guns will stand an extraordinary proof, denoting thus a resistance, more than sufficient, whilst others burst under a smaller trial without any warning being given of their approaching rupture; this serious defect results from the presence of two bodies, viz. Iron and Carbon, the mixture of which constitutes a material more or less liable to fracture, according to the proportion of the two.

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The Chemical combination produces a brittle compound, or which at least does not possess the necessary tenacity.

If also it is reflected, that the proper separation of Iron and Carbon, does not take place, except under the influence of a high temperature in the furnace, and of a gradual cooling of the mass which has been cast; that the means of ascertaining the proper temperature in the smelting furnace, and in the reverberating one, are uncertain; it is a sufficient explanation of the great difference in tenacity of cast iron guns, and which prevents their being used with confidence by many Continental Powers, otherwise than for their Navy and Coast defences.

The great object in the manufacture should be, not to produce at times guns of an excessive resistance, but of an equal and sufficient strength.

The principal defects in bronze are its want of hardness, and its liability to suffer from the chemical action of the gas, which tends to separate the two metals from each other, and also from the action of the gas, and ball. The bore is thus comparatively speaking soon injured, which is not the case in cast iron guns.

A larger portion of tin would make the metal harder, but less tenacious, and more subject to the chemical action of the gas; the contrary would make the metal softer, but more liable to injury from the mechanical effects of the gas, and ball, in passing out of the bore.

In order to preserve the gun from the action of the above forces which have always proved so detrimental to brass gun-metal, General Piobert of the French Artillery, proposed a different arrangement in loading, by which the first force of fired gunpowder was lessened, and the initial action on the ball modified; he obtained these results by using a longer cartridge (*Gargousse allongée*), whose diameter was less than that of the bore, so that a space existed between its upper surface, and the upper part of the bore, which the gas had to fill at the first moment of explosion. He considered that in long guns, the loss of effect at first would be compensated sufficiently by the ball being subjected to the action of the gas during the time it is passing along the bore, particularly as the first force impressed on the ball, is of much less importance in a long gun, than in a short one.

Experiments to test the value of the above arrangement, were made at Douay, with four 24-pr. brass guns, two of which were loaded with the ordinary sized cartridge; the results were, that the two first were rendered useless after 3161, and 3261 rounds each, and the latter were in good and serviceable condition after 3411 rounds; the question here is, whether the initial velocity is much lessened, and whether the elevation for a given range would not have to be increased; this is a point which experiment alone can decide, but it would seem almost worth a trial, when it is considered how much a brass gun costs, and how much sooner it is injured than an iron one.

The tenacities (in tons per sq. inch) of the different metals of which guns are made, are as follows,—Wrought Iron in bars (mean), 25½; Cast Iron, varies from 6 to 9¾; Copper, cast, 8½; do., hammered, 15; Tin, cast, 2; Brass, yellow, fine, 8; Gun-metal, hard, 16.

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No. 20.—*Account of the destruction of the Danish ship of the line, "Christian VIII," 84 guns, by fire from red-hot shot, and of the capture of the "Gefion" Danish frigate 42 guns, by the batteries at Eckenfjörde, in Schleswig, served by Prussian Artillery, assisted by Holstein volunteers, on 5th April, 1849; from information collected on the spot, and compared with accounts from other sources.*

By Lieutenant-Colonel Stevens, Royal Marine Artillery.

INTRODUCTORY.

Attentive observers will hardly have failed to notice, from the accounts given of almost all modern Military operations of whatever nature, that a dependency on Artillery in their conduct is greatly on the increase.

It matters little for our purpose whether armies have been employed of late as defenders of their countries' honour in foreign lands, or whether in the less glorious, but not less useful, work of preserving or restoring tranquility at home. Our own concern is rather with the end proposed, the means employed, and the causes of failure or success.

In the late struggle to suppress revolt in Hungary we have seen the two great Military Powers of the East of Europe, taxed to their utmost, bring into active employment nearly one thousand Field and Siege Guns of various calibres; and if we seek the reasons why the energies of Russia and Austria combined were so severely tried, and victory remained so long in doubt, we may find it to have been owing greatly, if not mainly, to the care which the Magyar Leaders appear to have bestowed upon the Organization and Equipment of their Artillery. This fact is better illustrated by the closing scene of the Hungarian war. A beaten army reduced by successive defeats, retreating before and amongst overwhelming numbers, and unable to extricate itself by force or flight, surrenders, or at least its remnant, amounting to 9 regiments of hussars, and 32 battalions of infantry, in all, say 40,000 men, surrenders, and with that force are still found in a condition of active efficiency (for not otherwise could they have kept pace with the rapid marches which preceded the surrender) no less than 138 Field Guns.*

Existing animosities have effectually prevented, and will probably for ever prevent effectually, any trustworthy account of this Campaign from

* On the surrender of Bem and Guyon's Corps at Deva, 8000 men, and 50 guns were taken; the total captures under Prince Leichtenstein amounted to 25,000 men, and 175 guns. The last Guerilla Band unconquered and in arms at Munkaes is reported to have consisted of 8000 men and 20 guns. Allowance may be made for desertions, but the force of *matériel* of all calibres in use, as reported, must still appear enormous.

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reaching us, but the force of Artillery accompanying the several Austrian and Russian Corps has been more than once given in detail by the German papers, and the force and *matériel* of General Georgey's army at the time of its surrender are as notorious as the fact itself.

But not in Hungary alone, at Paris, Vienna, Prague, Frankfort, Naples, and finally at Rome, the late melancholy sacrifice of life and property has been generally terminated by the employment of that arm which Austria has not unaptly termed the *ultima ratio Regum;* and by a mighty *duel d'artillerie* has been ended, let us hope, one of the bloodiest struggles which history has as yet recorded in connexion with our annals of conquest in the East. It becomes us, therefore, deprived as we "happily" have been of all participation in the late civil wars of Europe, and doomed, must we say as unhappily, to gather only from afar, and by report, that experience which a proportion at least of our Cavalry and Infantry are enabled to acquire in the field in India, to let slip no opportunity of collecting and circulating among ourselves such professional information as accident, or (as in the present instance) the zeal and kindness of a Brother-Officer may throw within our reach.

The account which Colonel Stevens has collated and placed at our disposal was prepared after a personal visit to the scene of action; the Plan is a reproduction of a publication which appeared at Hamburg.

A note has been added to the text relating to the use of Grates in heating shot, which is extracted from the *Aide Mémoire* of 1844, and which may not prove useless or uninteresting.

It does not lie within the scope of these few prefatory remarks to compare the relative chances of Land and Marine Artillery when opposed to each other as in the present instance. Perhaps every similar modern action (except one) in which our arms have been engaged has been determined by, or presents leading features of what objectors to any particular theory upon the subject would call, accident. At one time, a strong wind and bad seamanship; at another, the unlooked-for explosion of a magazine; and the opportunity of anchoring at close quarters obtained, in a third instance, by surprise, might be alternately pleaded in exception. Gibraltar alone furnishes a case of attack and defence upon a large scale and of the same nature, having been premeditated and forseen, and therefore deliberately prepared for on both sides.

But if it be useless to speculate upon hypothetic cases in war, where fortune proverbially reserves to herself a larger share in the determination of results than elsewhere; and if, after all, individual bravery, energy, and science will often cut the knot which adverse fortune may have tied, yet are such instances as Colonel Stevens has recorded, of the greatest value to Officers in our service, because it is precisely to such collisions with an enemy that we are most exposed by the detached and often maritime and insular situation of our Officers and men, rendering similar attacks from hostile shipping possible.

The present diplomatic relations of the world may perhaps not justify the expectation of any extensive expedition being fitted out in England, or against her; but moments of rupture are not unlikely, and such moments,

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should they occur, would offer opportunities of promise in many quarters of the world throughout our half-armed Colonies, against which the experience and practice of the Prussian Artillery at Eckenfjörde may stand us in some stead.

E. M.

ACCOUNT

BY

LIEUTENANT-COLONEL STEVENS,

ROYAL MARINE ARTILLERY.

A reference to the accompanying plan will shew the position of the Bight or Bay of Eckern, or as it is usually called Eckenfjörde, which runs inland from the Baltic, nearly due west, for several miles. It is more than two miles wide at the entrance, but becomes gradually narrower, and at the part where the batteries are situated (although the distance from the North Battery to the South Battery, as they are termed, may amount to about 1000 yards) does not exceed 900 yards in width.

The town lies about 700 yards further westward, on a projection of the shore which forms the extremity of the Bay. Beyond the town is a small Lake connected with the Bay by a narrow channel.

The North Battery is about 18 feet above the level of the sea; it is tolerably well secured by palisades and a ditch, some part of which is wet, and was armed with two 8-inch guns (French calibre) for firing shells, and with two brass 24-pounder siege guns, mounted on traversing platforms, to fire over the parapet *en barbette*.

The South Battery is not more than 12 feet above the sea level; it is surrounded by palisades, and is additionally secured in rear against assault by a Blockhouse, and by a Redoubt situated upon a bank about 30 feet in height, and nearly 100 yards to the eastward. This Battery contains a permanently built brick furnace for heating shot, with implements for serving them. The construction of the furnace is similar to that of the furnace shewn in the *Aide Memoire a l'usage des Officiers d'Artillerie*. The armament of the South Battery consisted of four 18-pounders, of about 38 cwt., also firing over the parapet, *en barbette*, from traversing platforms. The guns were not served with hot shot at the commencement of the attack, but on the renewal of the action at the termination of the truce, the shot were heated and used with fatal effect. Junk wads were not employed; but in their place, wads made of straw were used, and others of sea-weed, which being wetted and drained, served their purpose well.

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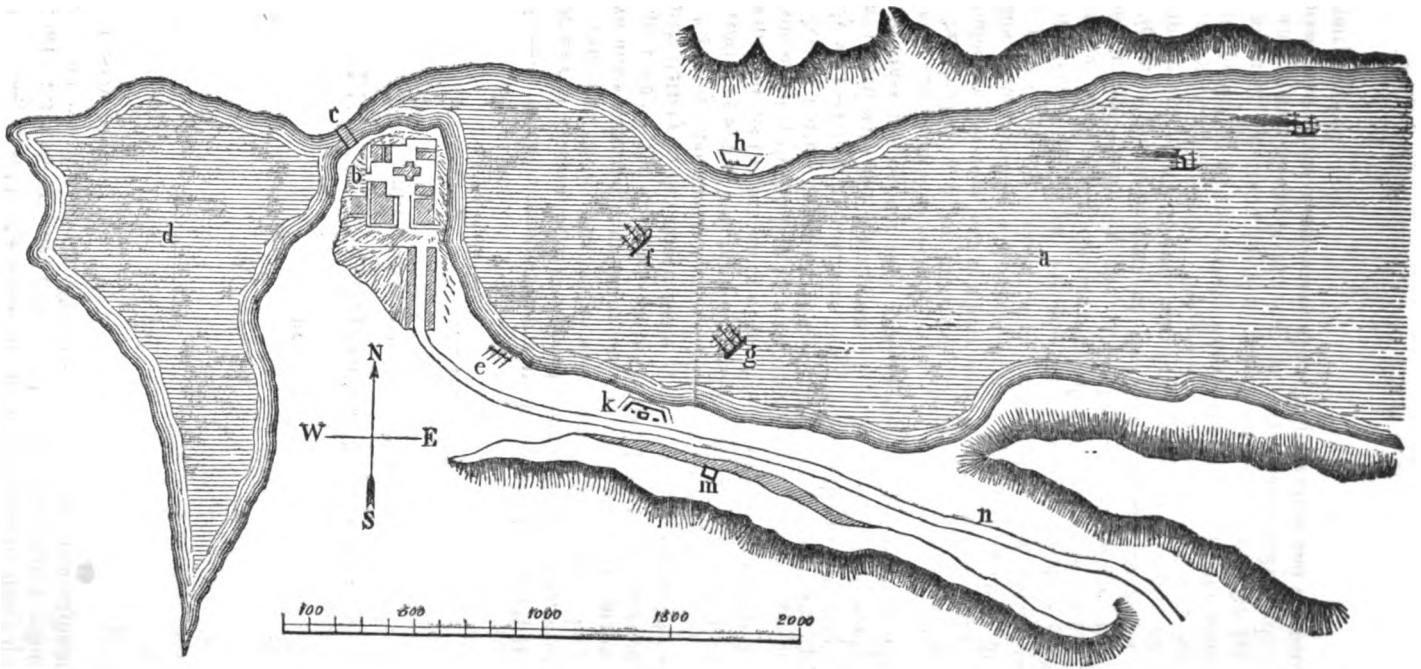
Bay of Eckenfjörde in Schleswig, shewing the position of the Danish ships of war, and the Enemy's batteries on the 5th April, 1849.



a Bight or Bay of Eckenfjörde.
b Town of Eckenfjörde.
c Bridge.
d Small Lake.
e 4 Nassau Field Howitzers.
f Gefion.
g Christian VIII.
h North Battery.
k South Battery.
m Redoubt.
n Road to Keil 14 miles.

G. H. Wreford, R. M. Artillery.

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The profile of both batteries has the strength usually given to works intended to resist the fire of heavy Artillery. The parapets are 6 feet in height, and consist of a sandy earth, having their superior and exterior slopes revetted with sod work, and the interior slopes revetted with planks retained by upright timbers.

Both Batteries were served by Prussian Artillery, aided by Holstein Volunteers, and were evidently in a more efficient state than would be supposed from the descriptions of the engagement given in the public newspapers.

The Redoubt was garrisoned by Infantry alone without Artillery.

The attack commenced about 8 a.m.; a strong breeze was blowing almost directly into the Bay from about east-north-east, "Christian VIII," "Gefion," and the two war steamers, "Geyser" and "Hecla"* stood in, keeping the north shore and engaging the North Battery as they approached, "Christian VIII" also firing at the South Battery, both Batteries returning their fire.

After much expenditure of ammunition, the Danish Commander, Captain Paludin, perceived that whilst the ships were suffering greatly, they had made no material impression on the Batteries; "Christian VIII" had even been set on fire by the 8-inch shells of the North Battery, but the fire was extinguished by the exertions of the Officers and crew. This latter vessel now stood over and engaged the South Battery more exclusively, firing by salvoes of broadsides. It is said that she fired twenty-six such discharges, the batteries returning the fire by single guns. The salvoes from the ship mostly missed the South Battery, taking effect often on the bank in its rear, and from 50 to 100 yards eastward.

Referring to the width of the Bay, stated before to be in this place 900 yards, it may be well here to remark that from the flatness of the beach, the deep water channel in which large ships can float, can hardly be estimated at more than 600 yards across. So restricted a space to move in must therefore have proved the most embarassing of the difficulties with which the ships had to contend. Considering also the relative position of the batteries towards each other, together with the direction of the wind, E.N.E., it followed that on whichever tack the ships were put they presented a bow to one battery and a stern or quarter to the other. They were also obliged to keep on a wind, for had they attempted to go at large they would have run further in, and have become still more embayed; under these circumstances, except occasionally, the Danes could bring but few guns to bear. This disadvantage is moreover likely to have occurred to them in a still greater degree since their ships do not afford the same lateral scope, by several degrees, for pointing their guns in the ports, which is allowed in ships in the British service.

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* From various concurrent accounts it appears that there were in the offing several other vessels, besides those named above, having troops on board, and flat boats for landing them, but that such an operation "*could not be thought of*" in consequence of the strong wind and the sea on.

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At an early period of the action, "Christian VIII" was taken in tow by one of the steamers, but the tow-rope was cut by a shot, and shortly after the steamer's starboard paddle was cut away, when she stood out to sea. Accounts state that the other steamer was also greatly crippled by shot, the damage done to both vessels being so considerable that neither were in a condition to render assistance to the ships, and that they only escaped themselves with difficulty.

Still no impression seemed to be made upon the batteries, while the ships were much damaged, and many men on board were being killed and wounded. The Danish Commander, therefore, finding himself moreover unable to retreat, had recourse to a flag of truce for a parley, in which he expressed his intention to the effect that he would blow the town to atoms if he were further molested in getting out of the bay. The reply of Major Jungman, commanding the Artillery, was "The Danes must remain as prisoners, or the firing would recommence." After three hours discussion with the Civil and Military Authorities on the spot, to no effect, these hard terms were refused, and the combat was renewed.

The Prussian Artillery had availed themselves of the interval of truce to remount one of the 8-inch guns that had been dismounted in the North and to heat their shot in the South Battery. The manner in which the gun in the North Battery was dismounted is remarkable; a shot, probably from one of the steamers at a distance, descending from some elevation, struck the gun somewhat in rear of the left trunnion and forced the piece (perhaps of 60 cwt.) out of its carriage. The gun fell to the ground, and the carriage was somewhat injured, but neither gun nor carriage were disabled.

When the firing recommenced "Christian VIII" made an attempt to work out, but the ship refused stays and anchored at less than 300 yards from the battery. "Gefion" anchored also. Both frigate and line of battle ship tended at their anchors in a most unfortunate position, each with their bow to the North and their stern to the South Battery, or nearly so. The ships were thus exposed to a raking cross fire which they could but imperfectly return. About six o'clock in the evening, "Christian VIII" became decidedly on fire, somewhere abaft, from the red-hot 18-pounder shot, and her crew commenced abandoning her, the greater part of her people reaching the shore in her boats. Shortly after "Gefion" surrendered and the firing ceased. The Danes were humanely received by the Prussians and the Holsteiners, and particularly by his highness the reigning Duke Ernest of Saxe Coburg Gotha.

"Christian VIII," after burning some time, blew up, but considerably sooner than was apprehended, by which, it is said, not only did a hundred Danes perish in her, but also several Holsteiners who had gone off to the ship when the firing ceased.

Towards the latter part of the action, a Field Battery of Nassau Artillery, consisting of four howitzers (corresponding nearly to our 12-pounders) arrived and very gallantly put themselves in position against the ships and opened their fire; according to some accounts these howitzers rendered material service; according to others, but little, as they are represented to have arrived when the results of the day were evident. In

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this matter it is not easy at the present moment to arrive at truth, for from political causes the Holsteiners, and still more a portion of the inhabitants of Hamburg, had become so incensed at the Prussian Government as to be inclined to ascribe the results at Echenfjörde to the Nassau Artillery, or to any other body, rather than to the Prussians, notwithstanding that they had fought so stoutly for the Holstein party.

But little injury, commensurate with what might have been expected from the number of guns to which they had been exposed, was sustained by the batteries. In the North Battery one of the 8-inch guns was dismounted; as has been mentioned, by one of the first shots fired, but little other damage was done, unless, as I think, I heard that a second gun was dismounted, but of this I am not sure. In the South Battery two guns were hit, one on the right side of the face, the other on the right side of the chace; some shot struck the Block House, but there were no casualties here, and the total loss of the Prussians amounted only to two killed and three wounded. Their merit, however, must not be measured by this scale, but by the cool and effective use which Major Jungman made of his guns.

The bravery and endurance of the Danes is sufficiently manifest in the simple narrative I have given without further remark from me, though the result of the conflict was disastrous to them. I cannot, however, terminate this account without stating that it was universally current at Hamburg and Holstein that Captain Paludin went into combat in the Bight with a wind blowing nearly directly in, contrary to his own judgement, but in obedience to orders "from a superior authority," left him no course but to attack immediately.

As it was before observed (and the observation was confirmed by several who witnessed the engagement) "Christian VIII," during those short periods of the day when she could bring her guns well to bear, fired by salvoes of broadsides, instead of confiding the precise moment to fire to the individual director of each gun. I can but reflect with serious consideration on this instance, firing by salvoes of broadsides and their complete failure of effect; but I also regard it as a useful warning against a systematic use of side scales and pendulums, as means of being enabled to discharge whole broadsides simultaneously by a single word of command or signal, thus interfering with the preception and expertness of the British Seaman, instructed as he now is in the use of the sights with which his gun is equipped. To the captain of the gun should be confided the trigger-line, and with it the important trust and duty to fire, when his eye being brought down to the plane of the sights they coincide with the object. Mechanical systems tend to lessen the sense of individual responsibility, and of self-reliance, on the part of those who direct our guns afloat in the time of battle, the critical moment when such high feelings are most needed.

It is remarkable that after the experience obtained in the British Army during our achievements of the last war, the Authorities should, with the view of rendering Infantry fire more effective, have ordered to be discontinued the use of battalion and platoon firing by a single word of command, the word fire being no longer given, but the exact moment to

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pull the trigger being left to the individual responsibility of the soldier. How evidently more necessary is it at sea, where the Artillery is always more or less under the influence of motion, that the guns should be discharged at the instant the sights are on, or perhaps a moment of time before they bear. This manifestly cannot be effected otherwise than by a cool feeling of self-reliance on the part of the man who holds the trigger-line in his hand, with his eye down to the plane of the sights. I cannot, therefore, help thinking that if the service of the Danish guns had been more left to their individual directions, different results would have marked the fight at Eckenfjörde.

NOTE.

When common grates for heating shot must be resorted to, for want of any better, or more economical appliance, their efficiency may be much increased by means of the following simple proceeding, recommended in the French *Aide Mémoire* of 1844 :—

Let a hole in the ground be cut corresponding in dimensions to the size of the grate, open towards the front, and deep enough to allow four inches clear for draught of air under the lower bars. Fit the grate into the cutting, with its feet resting upon bricks or stone, and form a flat arch over the top with sheet iron or other incombustible material, retaining an opening in rear of about five inches square, as a chimney, and covering the arch with thick sods or earth to retain heat. A thick sod will make an efficient damper, and enable the draught to be regulated so that no flame shall escape from the front of the furnace. Lay the shot in the grate, leaving about one-fourth of its depth free in front for fuel. In this space and under the grate lay billets of wood of about 12 or 14 inches long, and 3 inches in diameter, and a small reverberatory furnace will be found capable of heating a 32-pounder shot in an hour, and equal to the supply of three guns, requiring only one man for its service.

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No. 21.—*Remarks on Sleigh Carriages in the service of Artillery.*

By Captain TOWNSEND, R.A.

Sleighs of three different patterns have been employed for the conveyance of Field Artillery in Canada; that first used* consisted of two brackets for the gun to rest on, placed on the simplest form of sledge. The platform of this sleigh was about 8 inches from the ground, and was inclined a little upwards at each end; the runners (or part resting on the ground, in fact the substitute for wheels) were placed at about 27 inches apart, that being the usual breadth of the *traineaux* used by the French Canadians, and consequently of the winter roads in Lower Canada at the time these sleighs were introduced into the service. The principal objections to this sleigh were that it soon got injured in travelling, particularly when passing over uneven roads, from the transoms which connected the runners coming in contact with large lumps of ice, snow, &c. arising from their being only raised about 4 inches from the ground; and that the gun was not sufficiently raised to permit of its being readily laid, notwithstanding which it was much too easily overturned when travelling. The first and second of these defects were, in a considerable degree, overcome by the introduction of the sleigh called Sinclair's pattern, after Major John S. Sinclair, R.A., which was first made about the year 1813; but the third objection, that of easily overturning, remained in its full force.

Sinclair's Pattern.—In this sleigh the summer carriage, having the axle-tree and wheels removed, was placed with the axle-tree bed resting upon runners about 16 inches high, the trail resting on the ground and being to the rear in travelling.†

A model of the last mentioned sleigh, or one very similar to it, was sent from Canada about the year 1829 or 1830, and a Committee of Officers, consisting of the Select Committee, with the addition of four Officers‡ who had served in Canada, was assembled by order of the Master-General to report upon it. The result was the rejection of that sleigh, and the proposal of the sleigh now used, which is commonly called the "Woolwich Pattern."

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* Sleighs were probably introduced soon after the conquest of the country. In a Store Return, dated Quebec, 1783, several "sleds" are included.

† Generally speaking, with sleigh carriages the muzzle of the gun is to the front in travelling. Sleighs should be made so as to travel with the muzzle either to the front or rear, on account of the difficulty of either reversing or slewing the carriage round in deep snow.

‡ The Committee consisted of—

Lieut.-Gen. Sir J. Macleod,	Colonel Williamson,	Lieut.-Col. Wallace,
— Cuppage,	— Drummond,	Major Mercer,
Major-Gen. Miller,	— Sir A. Dickson,	Captain H. G. Jackson,
Colonel Sir A. Fraser,	Lieut.-Col. Sir J. May,	Lieutenant Wilford.

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Woolwich Pattern.—This sleigh is much superior to either of those previously mentioned. Although high enough to permit of the gun being laid with tolerable facility, it travels well over the worst roads with the muzzle either to the front or rear. It has been complained of as being soon injured by firing, but this very serious objection arose from a faulty manner of putting the several parts of the sleigh together, rather than from any defect in the plan of the sleigh itself.* But in the construction of new sleighs it would perhaps be well to strengthen a little those parts which have been found to suffer most from firing, so as to enable them to bear a much more severe trial than they are now ever subjected to.†

The "Woolwich Pattern" consists of a platform 6 feet 10 inches long, and 3 ft. 10 inches wide, placed on runners 16 inches high, upon which also rest two strong transoms to which the brackets supporting the gun are secured. A box is placed on each side of the gun, together capable of containing about thirty rounds of ammunition, and which serve as seats for Nos. 1 and 2. These boxes usually contain the shot and small stores, carried in the axle-tree boxes and centre limber-boxes, as well as long reins for driving when in single draught.

The extreme breadth of the runners is three feet, which though broader than the sleighs used by "the habitans" of Lower Canada, is not so broad as to prevent their travelling over any of the ordinary roads of the country. The distance to which the platform extends beyond the breech of the gun, renders the operation of laying a little inconvenient; this distance might perhaps be somewhat shortened with advantage, particularly as it would bring the centre of gravity of the gun more in the centre of the sleigh; and the moving of the handspike about six inches to the right of its present position when in action would also tend to facilitate the laying of the gun.

Captain Tylden's Sleigh.—Besides the sleighs above mentioned, sleighs of two different patterns have been proposed by Captain Tylden, with the view of conveying the summer carriages with the guns. The first of these sleighs was of such a breadth as to allow the wheels of the gun carriage to rest on the runners, the gun being mounted on its carriage, and the latter placed on the sleigh. In the vicinity of large towns, where the roads are wide, this sleigh answered perfectly well, but it was unsuited for the usual country tracks, which in Lower Canada seldom exceed three feet in breadth,

* The brackets on which the gun is supported rest on transoms, and these again on runners, the whole being secured by iron bolts. The firing caused these bolts to tear away the wood work. The brackets are now "let in" to the transoms, and the latter into the runners, which prevents the whole stress coming on the bolts.

† Sleighs have hitherto been built by contract, the price being 13*l.* to 14*l.* sterling for the gun sleigh, and 10*l* to 11*l* for each ammunition sleigh. The timber used was American, which is inferior to that of this country. They should be made of English oak, with the exception of the shafts, splinter bars, and platform, the two former of ash, the latter of fir. If made in the Storekeeper's Department at Montreal, uniformity of construction, good materials, and the best workmanship would be ensured.

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and sometimes are even less; the common *traineau* being only 2 feet 8 inches broad. Captain Tylden being satisfied that the great breadth of this sleigh would prevent its being introduced into the service, proposed another pattern considerably narrower than the former, being 4 feet 2 inches broad. In general appearance the second pattern somewhat resembled those now in use, but were so constructed that four sleighs conveyed the summer carriage of a subdivision, the sleighs, however, being complete in themselves without the summer carriages (which was not the case in the former pattern), three sleighs being then the complement for a subdivision.

Although these Sleighs were in every respect much superior to the pattern last mentioned, their breadth was still considered too great, and consequently they have not been adopted in the service; but no one who has seen either the sleighs themselves, or the very perfect models of them constructed by Captain Tylden, can fail to acknowledge that very uncommon skill and ingenuity has been displayed in their construction, and as much achieved towards the object in view (namely, to have the means of conveying the summer carriages with the guns) as it is perhaps possible to attain.

The sleighs now in use are capable of conveying the summer carriages in case of emergency, though probably not without injury, except for a short distance, or on very good roads, and while so loaded the guns cannot be brought into action. The sleighs can also be carried upon the wheel carriages.

The manner in which a gun with its ammunition is arranged on sleighs is as follows:—Three sleighs form one subdivision; on the first is mounted the gun, with its side arms, slow match box, and port fire cutter; Nos. 1 and 2 are carried on this sleigh, sitting on the boxes previously mentioned, No. 1 on the *left* and 2 on the *right*.

The front box of the wagon body and the gun limber boxes are carried on the second sleigh. The Nos. on this sleigh are 3, 4, and 5; No. 3 in front on the wagon box; Nos. 4 and 5 in rear on the limber-boxes.

On the third sleigh, the rear-box of the wagon body and the wagon limber-boxes are placed. No. 6 sits in front on the wagon box, 7 and 8 in rear on the wagon limber-boxes. The knapsacks are carried on the two ammunition sleighs.

With a 6-pounder battery, the detachment mounted and in heavy marching order, the weight of the sleighs is as follows:—

	cwt.	qrs.	lbs.
Gun sleigh	17	1	15
No. 1 ammunition sleigh ..	18	3	22
No. 2 do. do. ..	20	2	0

When the roads are good, two horses are sufficient for each sleigh; on bad roads, it would be necessary to dismount the detachment, and should the roads be nearly bare of snow, four horses would be required for each sleigh. There being the same number of horses to a subdivision in winter as in summer, it has been usual, for the sake of appearance, to put four

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horses to the gun sleigh, and two to each of the ammunition sleighs. This arrangement is only suitable for parades and exercise on good roads, as the gun is the lightest of the three sleighs which compose a subdivision.

Limber Sleigh.—As the moving with so many carriages is manifestly inconvenient and objectionable, and as the gun horses have to pass to the rear on the gun coming into action, with the ends of the shafts trailing on the ground, several attempts have been made to introduce a limber sleigh so as to bring the battery of sleighs to correspond with a battery of wheel carriages; hitherto, however, these attempts have not been attended with success.

There is one objection to a limber sleigh which should be well considered before such a change is adopted, which is, that should a battery be advancing on a narrow track, with deep snow on each side, and that it should be necessary to bring the leading gun into action, there would be almost an impossibility of passing the limber to the rear; the horses would lie down or plunge, and probably upset it. The consequences which might arise from such an occurrence it is unnecessary to speculate upon.

When a battery is on a march, the snow being deep and the roads narrow, it will, generally speaking, be found most convenient to have the spare horses in front, instead of in rear of the battery; or they might be distributed between the subdivisions in front of those they are intended to assist—the reason being that should a sleigh get into a difficulty and require an additional pair of horses to be attached to it, they must, if in rear, move forward through the deep snow, sometimes a matter of no little difficulty; whereas if in front, they can get off the track, halt till the sleighs between them and the one they are to assist have moved on, and then move to it on the beaten road.

Lassoes.—Lassoes answer well to assist in getting sleighs out of difficulties, in assisting up hill, or in holding on when going down; they however, lengthen the column considerably.

When descending a hill, the drivers should go straight down, however steep; the steeper and smoother a descent is, the greater being the danger of the rear of the sleigh slewing round. When a sleigh "slews" in this manner, the horses should be thrown off to the side to which the sleigh is inclined to slew, and if this is not sufficient to check it immediately, they should be pulled up.

Single Draught.—When the road is very narrow, it sometimes becomes necessary to put the horses into single draught. With two horses to each sleigh, the off horse remains in the shafts, which are shifted to the centre of the sleighs, and long reins being buckled to their bridles, Nos. 2, 3, and 6 drive from their seats. The near horses have each a pair of leading traces hooked on to their collars, and are hooked on in front of the off horses; the drivers remaining on their horses. Should a third horse be required, if an off horse, he should be placed between the others, and as he cannot be led, the leading rein may be attached to the crupper-ring

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of the leading horse. When it is expected, previous to marching, that it will be necessary to shift to single draught, it will save much time to have leading traces put on such horses as require them, in addition to the wheel traces required for double draught. It should perhaps be mentioned that spare leading traces are always carried in Canada with both summer and winter carriages.

As no plan has yet been adopted by which the guns may at all times, during the winter season, be accompanied by both descriptions of carriages, it may not be out of place to consider here when one or the other should be preferred, and whether it is in any case necessary that the guns should be accompanied by both.

I believe it to be the opinion of the most experienced officers, that in the early and latter part of the winter season, it is safest, and therefore best, to move if possible with wheel carriages, and that sleighs should only be resorted to when the former could not travel, or when no doubt whatever could exist as to the wheel carriages not being required. Should a heavy snow storm occur, and a battery without its sleighs be required to march, it could only do so by making use of the country sleighs; these would answer for conveying the ammunition and carriages if necessary; but the gun would be perfectly useless, unless mounted on a sleigh constructed for the purpose. On the other hand, should a battery on sleighs be obliged to resort to the wheel carriages of the country (a contingency to be carefully guarded against as before observed) the same remark as in the former case applies. The ammunition, &c. may be transported in carts, but the gun must have its carriage, and if possible its limber to render it serviceable.

It may then be concluded, that the whole of the carriages of both natures are at no time absolutely necessary to be present with the guns, provided country carriages can be obtained, but that it may in some cases be advisable that the gun sleigh should accompany a battery on wheels, and the gun carriage and limber, or at least the former, a battery on sleighs.

I am not aware whether sleighs have at any time been used for Field Service by the Americans, at present they have none, so that we can gain nothing from their example or experience.

It would be interesting to know how the Northern European Powers, especially the Russians, move Artillery in winter, and to compare their systems with our own.

NOTE.

A few memoranda relative to exercise with sleighs have been appended to this paper, which, though not of general interest, may be so to Officers attached to batteries in Canada.

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Post of the Detachment with Sleigh Carriages.

IN ACTION. IN FRONT. IN REAR. — Same posts as with wheel carriages.

IN ORDER OF MARCH. — The position of the gun being reversed (*i.e.* the muzzle to the front instead of to the rear), it becomes necessary to alter the position of the detachment, that each man may find himself on his proper side of the gun when it is brought into action.

The odd numbers, or front rank, will be on the left, or near side; the even numbers, or rear rank, on the right or off side, No. 1 at the wheel horses' heads; Nos. 2 and 3 in line with the muzzle; 4 and 5 in line with the breech; 6 and 7 one yard in rear of 4 and 5; 8 and 9 one yard in rear of 6 and 7.

MOUNTED. — No. 1 on the left, No. 2 on the right of the gun sleigh; No. 3 on front box No. 1 ammunition sleigh; Nos. 4 and 5 on rear box of No. 1 ammunition sleigh (4 on the right, 5 on the left); No. 6 on front box of No. 2 ammunition sleigh; Nos. 7 and 8 on rear boxes of No. 2 ammunition sleigh (7 on the left, 8 on the right); No. 9 on front box of No. 1 ammunition sleigh.

In consequence of the narrowness of the winter roads, it will generally be found impracticable to march with detachments in front, in rear, or in order of march; and for several reasons it is better that the men should march in rear of their respective sleighs. Their places from right to left will be as follows:—

IN REAR OF SLEIGHS. — Nos. 2 and 1 in rear of gun sleigh; 4, 5, 3, in rear of No. 1 ammunition sleigh; 6, 8, 7, in rear of No. 2 ammunition sleigh.

Change of position of Detachment.

FROM FRONT TO ORDER OF MARCH. — No. 1 gives "Left face, Quick march." The ranks open out—each No. halts at his post, and they front by signal from No. 8; when there is no No. 9, No. 8 would be in the front rank; on the word "Form order of march," he should fall back so as to lead the rear rank when faced.

FROM REAR TO ORDER OF MARCH. — Nos. 1 give "Right face, Quick march."

FROM FRONT, OR REAR, TO REAR OF SLEIGHS. — Commander gives "Form in rear of sleighs." Nos. 1 give "Left face, Quick march." The ranks open out, and the Nos. form single rank in rear of their respective sleighs. From order of march, the formation is made in the same way, except that Nos. 1 give "Right about face."

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FROM ORDER OF MARCH TO FORM DETACHMENTS FRONT.

Nos. 1 give "Quick march"—ranks close and wheel to the right; Nos. 1 give "Halt, front," and place themselves on the right of their detachments.

In forming detachments rear, the wheel is made to the right.

FROM REAR OF SLEIGHS TO ORDER OF MARCH, OR TO FRONT OR REAR.

Nos. 1 give "Quick march;" the Nos. move on their respective sides, and halt at their places in order of march. When ordered "Detachments front" or "rear," the same word is given, and when in the proper position, "Right wheel," and then "Halt, front." When the formation is in rear, No. 2 falls back to enable him to cover No. 3, when the detachment is halted.

NOTE.—On the word "Dismount" being given, the detachments after dismounting will remain steady (instead of forming the order of march) until the manner in which they are to form is given. Should the battery be ordered to march, without any previous word of command being given, they will form in rear of their respective sleighs.

Coming into Action.

ACTION.

No. 1 unhooks swingle tree, places it on the back of the near horse, then steps in and takes hold of the shafts on the near side; No. 2 takes hold of the shafts on the off side, and the two Nos. lift them off, laying them gently on the ground. No. 3 as soon as he comes up places the hook of the swingle tree in the crupper-ring (hook upwards). No. 1 gives the word "Drive on" when all is ready. In coming into action to the front or to the right, the gun horses move to the left and form on the left of No. 1 ammunition sleigh. In action left, they move to the right, and form on the right of the same sleigh.

As it is difficult to reverse in deep snow, particularly from a halt, it is best when it is intended to come into action to the *front* to give the word "Prepare for action," when the leading (*i.e.* Nos. 1) ammunition sleighs will increase their distance to 10 yards. Should this word not be given, the sleighs must reverse in the same manner as in coming into action with wheel carriages, the two sleighs moving as if one carriage. It is conceived that with sleighs (at least as at present constituted) the muzzle should be to the front in advancing, and to the rear in retiring. Should, however, the commander wish to retire with muzzles front, the word of command would be "Rear limber up, muzzle front."

On coming into action, if the gun does not point in the proper direction, it is brought round by the Nos. seizing the hooks on the front and rear of the sleigh—1, 2, 3, in front, 4, 5, in rear, assisted if necessary by the higher Nos.

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LIMBERING UP. This is done by the Nos. who unlimbered. The wagon sleighs (which in action are at the distance of 10 yards* from the gun) close up to three yards distance.

Hooking in.

When a battery is ordered out, the men form the order of march, as with wheel carriages, and shift after hooking in. When about to be dismissed, the men shift again so as to be on their proper side for unhooking.

1, 2, 3, and 4 hook in gun horses.
5 and 6 No. 1 ammunition sleigh horses.
7 and 8 No. 2 ammunition sleigh horses.

The gun horses are hooked in as with wheel carriages.

5 and 7 lift shafts, give the word "Ready," and hook in off horses

6 and 8 back shaft horses at the word "Ready," and hook in near horses.

Movements.

Filing from cloumn into line, and from line into column, may be said to be almost the only movements which would ever be required from a battery on sleighs; but for the sake of exercise, nearly all the movements which are made with wheel carriages may be made with sleighs, by making the two ammunition sleighs of each subdivision move as one carriage. It will, however, be necessary to make the interval in line eighteen yards, while in column of subdivisions the interval will be only thirteen yards, unless the drivers of the ammunition sleighs be instructed to increase the interval on breaking into column.

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* The recoil of guns on sleighs varies from 4 or 5 feet, when on rough ground or in deep snow, to 20 or 30 yards when on glare ice. In the latter case it is of course necessary to send the ammunition sleighs further to the rear; but the recoil may be considerably lessened by placing a small chain round each of the runners.

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Alterations required in the Harness of one Sub-division to adapt it for Sleigh Carriages, allowing four horses to the Gun, and two to each Ammunition Sleigh.

GUN LEAD.	No alteration.
GUN WHEEL.	Two straps of 2 feet in length, passing through buckles of hip straps to support traces of near horse. The traces are hooked to two chains, 16 inches long, attached to a swingle-tree.
WAGGON LEAD.	Wheel traces, 2 pair instead of lead. Breechings, off, 1; near, 1. Back bands, 1; 2 straps to hip straps of near horse to support traces.
WAGGON WHEEL.	Two straps to be attached to hip straps of near horse.
TOTAL ADDITIONAL HARNESS FOR ONE SUB-DIVISION.	Straps (2 feet) to be added to hip straps.....6 Wheel traces, pairs... ... ...2 Breeching { Near... ... ...1 Off ... ...1 Back bands 1

If additional wheel harness is used, instead of altering the leading harness, 2 single sets, 1 near and 1 off, will be required for each sub-division; and 6 straps of 2 feet each, to be added to the hip straps of the near wheel horses.

Weights of Sleigh Carriages.

Detail.		Lt. 6-pr.	12-pr. How.	9-pr.	24-pr. How.
		C. q. lb	C. q. lb	C. q. lb	C. q. lb
GUN SLEIGH.	Gun	6 0 0	6 2 0	13 2 0	13 0 0
	Sleigh	8 0 9	8 0 0		
	Side Arms	0 2 6	0 2 8		
	Total weight*	14 2 15	15 0 8		
No. 1 AMMUNITION SLEIGH.	Sleigh	4 2 1	4 2 15	21 0 17	20 0 25
	Ammunition	8 2 8	8 3 26		
	Side Arms, Knapsacks, &c. ...	1 2 18	1 2 21		
	Total weight†	14 2 22	15 1 6		
No. 2 AMMUNITION SLEIGH.	Sleigh	4 2 25	4 2 11		
	Ammunition	9 2 1	7 3 15		
	Intren. tools, knapsacks, &c.	2 0 1	1 3 7		
	Total weight‡	16 0 27	14 2 5		

* Add 3 cwt. 3 qrs. for two men.

† Add 4 cwt. 1 qr. for three men.

‡ Add 4 cwt. 1 qr. for three men.

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No. 22.—*Memoirs translated from the New Work of General Paixhan's, entitled "Constitution Militaire de la France."*

By Lieut.-Col. Brereton, C.B. & K.H., Royal Horse Artillery.

The questions to be found in these treatises are of great importance to the armies of the whole civilized world, for the complete solution of one of them, which has now been discovered, will undoubtedly lead to a complete change in the art of war in general. But this solution is to the Artillery of the Line of still deeper importance, for its very existence is threatened by the fact that the new French Musket has been rendered *superior* to field artillery, and which ceases to be, as hitherto, the most powerful arm of battles; but I know the science and buoyant zeal of the British Artillery, I am confident it will not passively suffer this *abdication*, and I am also confident that, when the facts contained in these Memoirs shall have been known and appreciated, the Royal Artillery will ere long discover the secret and antidote hitherto sought in vain. This is, but in a small degree, perhaps, a question of science; like the self-acting safety valve, it may possibly suggest itself to the least gifted amongst us. Yet, whoever may be that fortunate discoverer, he will have the glory of rescuing his corps from the degradation which now threatens it. With this object, I think it desirable to circulate these important papers; they state plainly the existing danger, and which is better, give the *results* of the several experiments made during a long course of years, to discover the secret which has hitherto eluded research. Yet these results are of the utmost value, for a great *principle* in the law of projectiles has thereby certainly been found, and in our search after the great discovery, even the failures will be as beacons to avoid them.

Wm. Brereton, *Lieut.-Col.*,
Royal Horse Artillery.

Woolwich, 6th May, 1850.

No. 1.—*Upon the new Musket of France.*

It is a general supposition that a great advantage would be to be able to fire, in the same space of time, a greater number of rounds; and the supposition is true, were the number of rounds only concerned, but it is less so of shots fired without aim, and in warfare such is the

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difficulty of transport that the power of expending ammunition exceeds that of the means of conveyance, therefore the constant anxiety of persons in command is to check the amount of firing, rather than to increase it. Improvement then is not required as to an increase of the number of shots fired, but that they may be so with more correctness and at a greater distance; this in fact is what has now happened for musket firing (already much improved since the Peace), it has been supplanted by the fire of the Carbine-Musket, which goes far beyond all reasonable expectation.

This is not the place in which to describe either this new arm, or the experiments by which skilful Officers have arrived at so great an improvement, but this is the result:

1stly. At a distance of 200 metres, against an object of two metres high, and two in width, that is, against a group of two or three men, an ordinary musket struck 44 times out of 100 rounds; with the new musket every ball of the 100 rounds struck the object.

2ndly. Against the same object, at the distance of 600 metres, the ordinary musket could not strike in 100 rounds, a field piece struck only 6 times; the new musket twenty-five times.

3rdly. Against the same object, placed at a distance of 1000 metres, or a fourth of a league, a distance at which the field piece deviated from six to eight metres from the point fired at, the new musket struck six times out of the 100 rounds; and even at that enormous distance, a marksman selected and, against a small object, hit it three times out of four shots. Thus art did here more than nature, for the best sight only can distinguish the point at a 1000 metres distant which this musket could accurately strike; and add to this that the new carbine-musket is not difficult of loading as is the old musket, that the recoil is less violent, and, what is very important, that the common arm now in use may be converted into the new one.

Napoleon has said that the musket is the best warlike machine invented by man; what would he have said if he had seen the new arm? What will be the consequences of this change, it becomes of importance to examine. At 600 metres, the enemy's case shot will scarcely range, and his round shot will only hit a group of two or three men six times out of a hundred rounds, but at that distance our Infantry can make every shot tell upon the vast group of men and horses in action with a gun; the enemy's Artillery must soon be silenced; the same may happen to our Artillery from the enemy's musketry. Thus, on both sides, if a battery of Artillery be placed in line, and in advance, and if a company of Light Infantry be placed in front of it, there will probably be a complete extinction of fire of Artillery. No doubt the cannon will always retain its superiority in penetrating deeply into the heads of columns, in clearing obstacles, and in acting at considerable distances; but the fire of Light Infantry

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will have a terrible effect against Field Batteries, and a swarm of Light Infantry upon the whole line, firing with such exactness, what will not be its effect upon an enemy's troops, upon its masses, and upon its Officers, who will be selected as objects by the most practiced of the marksmen? The operations, then, of Light Infantry will become the most important ones; but this change will be in nowise unfavourable to France which has invented the new arm; on the contrary, it will be beneficial to her, because no country has, in an equal degree, soldiers full of intelligence, of bravery, easy of acquiring instruction, and so adapted to the venturesome warfare of combatants entrusted to act upon their own conceptions.

But there is a still higher consideration with the ancient arms, which possessed neither a great range nor great correctness; the combatants engaged man to man, and the soldiers well disciplined, they for whom war was an art, had a decided advantage over soldiers less skilful. With fire arms, which strike from a distance, personal conflicts became less frequent, and the Infantry soldier, the gunner, were able to render service without being quite so perfectly instructed; but now that the musket has been rendered capable of striking a group of two or three men six times out of a 100 rounds, at a distance of a quarter of a league, and that at 200 metres distant every shot takes effect, it is evident that constant firing, and more especially the meeting of line against line, column against column, will become less frequent; that a change will take place in battles, and in manœuvres, and that in defence against an invasion, every National Guard, however little varied a country may be, is enabled, under many circumstances, to render the same service as a disciplined soldier.

Doubtless, the more effectual an arm has been rendered, the more skilful should be the man who is to use it. Assuredly, with the new musket, it is desirable not only to have special Corps for its use, but also to have in every Corps well selected marksmen, and kept a long time in the service. But in defending the country, when an enemy shall pass a defile, and we occupy the heights, when an enemy shall be on one side of a river and we upon the other, when an enemy shall advance upon our territory, and the people shall rise in his rear, against his convoys, upon his resources, against all his communications, is it not evident that then a peasant may fight without coming nearer than a quarter of a league (every one is brave at a distance), and thus the defenders of the country will be encreased tenfold? All the danger will be thus in future for the aggressors who shall advance; hereafter every invasion will find a powerful resistance from the people defending themselves, and conquerors will be under the necessity of carrying into war more troops than it would be possible to set in motion. Thus, this new arm, a French invention, will not only be favourable to France, but also to all defence against attack, it will be in favour of the weak against the powerful, favour-

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able to independence, to the rights, to the peace and the dearest interests of every nation, which is in fact the nature of real improvement.

No. 2.—Upon a new Musket which has been constructed, and upon a new Cannon which has yet to be constructed.

It is easier now to describe the great precision and greater range of the new Musket, than it was to give to it these qualities; but it will be useful to give this description, as it may be the best, perhaps the only means which may lead to the perfection of the Cannon, as the Musket has now been perfected. We will examine then the elements which have been combined in order to give so great an improvement to the Musket; let us enquire how far each of these elements have aided in the success obtained, and this labour will be a commencement of that which may lead to the same result as respects the Artillery Gun.

Rifled Carbines had been long celebrated for precision; since the Peace, continual experiments have been made in France with this arm; it was found that although these rifles did give precision, they gave no increase of range, but, on the contrary, a diminution; it was then investigated what should be the number of threads, what their curvature and their form, and what would be the proper cartridge for this rifle. With all these objects, experiments on a great scale were made by the troops, and also during the war in Algeria, these experiments, together with the researches on the subject by Messrs. de Ponteharra and Thiery, and other Officers, have thrown much light upon a question which it had not previously. The researches were also highly aided by a happy idea of M. Delvigne. Before that suggestion, the bullet had to be driven into the rifle by blows of the mallet, thereby rendering the firing very difficult and very slow; M. Delvigne shewed, in 1828, how the bullet could be made to enter easily into the piece, and to quit it in a forced state. This conduced in a great measure to its present success, and thence firing, until then difficult, became as rapid as ordinary firing. M. Delvigne's method required a chamber at the bottom of the rifle; this chamber, however, was not free from difficulty and inconvenience. M. Thouvenin proposed to substitute for the chamber a stem of iron within the axis, which, in stopping the ball, struck it so that the lead was made to penetrate the threads. This stem, which could be adjusted to the common musket, a great advantage, took its place amongst the elements which have been tried. Very recently, one of the Officers who have most contributed to the success of the new musket, M. Mignet, shewed that the stem could be dispensed with by means of a very simple contrivance (by whom invented I am not aware). The first experiments proved that in doing away with the stem, so

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far from diminishing the range and precision, both were increased; hence, with the exception of some difficulties which probably will be surmounted, simplicity and much diminution of expense have been obtained. The stem of M. Thouvenin, by facilitating the experiments has, however, contributed to the success gained; these experiments without the stem would perhaps have been less simple and less conclusive.

Another and very important element of success, was the elongated and cylindro-conical form of bullet. The elongation of a projectile has this advantage, that in an equal mass a smaller surface is exposed to the resistance of the air, and that a projectile may be driven with equal force by a fire-arm of less calibre. This idea is not a new one, it is even of long standing, for in 1770, M. Turpin tried it at La Fère and at Metz; it was tried in the years 2, 6, and 9 (Revolution) by M. Guiton de Morveau, with a cylinder of cast iron with a leaden ring; it was proposed by M. Bodeau in 1800; in 1815 it was tried in Russia with an elipsodiacal projectile; the English Colonel Millar experimented with the cylindro-conical form; experiments were made successfully at Charleville by Colonel Carron of the French Artillery in 1823; Captain Blois proposed the important suggestion of hollowing the projectile at the end, in order to send forward the centre of gravity; after these proposals came those of Messieurs Thiery, Delvigne, and others. Finally, during the year 1844, and subsequently, Messieurs Tamisier, Migne, and Thouvenin worked experiments which were very complete; they together combined the different elements of the question, and carried on their labours with great perseverance. The Duc de Montpensier, who commanded at Vincennes, gave them a co-operation which was equally scientific and cordial, and by his support prevented the delays and obstacles by which the commencement of every improvement is for the most part fettered. Amongst the new elements introduced were the circular grooves which M. Tamisier placed in rear of the cylinder of the projectile; these grooves oppose to the air's resistance surfaces perpendicular to the direction, and by an eventual resistance of the air conveniently provided for, the ball, when from any cause it has a tendency to alter its direction, is made to resume its intended one. These grooves are to the projectile what the shaft is to the javelin, feathers to the arrow, the tail to the rocket; and here I may be suffered to observe that in this a considerable application has been made of the principle which, in 1823, caused the success of my shell guns, a principle which consists in obtaining the amount of required action, and in overcoming the resistance of the air by increase of the mass and diminution of the velocity. Accordingly the old ball weighed only from 25 to 26 grammes, the new one weighs 48; the charge of powder for the old ball was 9 grammes, that for the new one is only $4\frac{1}{2}$; that is to say, that like what was done in the case of my guns, the projectile weighs almost double, and the charge of powder is reduced

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to one-half. Such have been the principal elements of the success obtained; and moreover, that the ordinary musket may be converted into a Carbine-musket, which is an important consideration in the practical introduction of this improvement. And here let us record an observation which may add further to what has been gained; it is, that it is much better to bring up the arm to the aim from below than from above, the firing is much more correct, and the reason is a palpable one; experience has proved its truth in Belgium, also in England, and the English have lately used this method on a great scale in their Indian war.

No doubt there will be some difficulties as to details, and some objections, more or less well founded, against the general adoption of this new arm. But what are details in a question which affects a change in warfare, and which change, as has been shewn, will favour the superiority of France, defence over attacks, and which is for the best interests of humanity.

The foregoing facts, as respects the new Musket, having been stated, let us now see what is the fact, and what can be done as regards Artillery, in order that this service may not remain powerless and stationary behind advancement, a position to which assuredly it will not willingly consign itself.

Many of the elements which we have enumerated may be in common with cannon and the ordinary musket, the form of the projectile, the great mass in lieu of the great velocity, &c.; but the projectile of cast iron cannot enter into the threads except by means of appendages or weak bolts; but the forcing cannot be effected to a projectile of cast iron as of one of lead; but the friction in the threads being caused by a mass 200 and 300 times heavier than a musket ball may destroy all, but, &c. &c. It is then indispensable that by some equivalent methods, what cannot be exactly copied may be substituted, and here is opened a vast field beset with obstacles. I am but imperfectly acquainted with what has been attempted for this object in different parts of Europe, but here are some facts upon this question.

Long since, in 1742, Robins pointed out that it would be very advantageous to have pieces of Artillery rifled spirally like carbines; this improvement, he said, would affect a great revolution in warfare. In 1844, when the success of the Carbine-musket was certain, I was directed to endeavour to obtain a similar result for guns of Artillery. I worked at this object; the 30th of July I delivered in my first report, and on the 27th December I gave in another upon the trials to be made. In 1845, according to some other proposals as well as mine, experiments were made at Vincennes with 6-pr. balls of different shapes; inconveniences were found, and neither precision or

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increased range were obtained. In the same year the Marine Department granted me an experiment, from which I sought a certain result, which result was not obtained.

About this time, and I believe even before it, experiments were made in Sweden, after the plans of a Piedmontese Officer, M. Cavalli, and the result of these experiments was an increase of ranges over the ordinary ones of one-seventh, and even of one-third.

The Marine also made some experiments for M. Delvigne (to whom is due one of the principal causes of the success of the new Musket). It was considered by the Marine that the results of the experiments were not satisfactory.

During the present year some new trials of M. Delvigne were exhibited; of these trials (amongst which is the application of an ingenious idea) one was by means of projectiles of lead, which does not solve the general question as to pieces of Artillery. The other was upon projectiles in cast iron, supplied with moveable appendages, and to the present time these moveable appendages have been a failure; there were already different kinds of these tried in the experiments at Versailles, mentioned above.

The newspapers, and probably some memoirs of private individuals, have proposed different methods more or less worthy of consideration. Finally, the question is still agitated, but the solution and the probable means by which to arrive at it are still to be sought; yet this solution must be possible, seeing that in Sweden it has been partially obtained.

That it is possible, is clear from a close attention to and consideration of existing facts; it is possible, if, in place of giving theories for solution, we restrict ourselves (which is a hundred times preferable) to *seek* for the cannon what has been *sought* for the musket. But it is necessary to seek logically, simply, and with perseverance. I am certain of the possibility, if we can surmount, by practical methods, simple in their nature, the difficulties presented by the cannon, and which the musket did not present; and this discovery is not alone possible, it is absolutely indispensable, unless it be intended that the Artillery shall be put down by Light Infantry; and if the Artillery desire, instead of remaining in the back-ground, to made a progress in advance, which will give to it, on the one hand, guns rapid in manœuvre, and on the other, guns more formidable as to precision and length of range.

In this, as in every thing, in order to obtain useful and honourable success, three things must be combined, KNOWLEDGE, the WILL, and the POWER.

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No. 3.—On the means of preventing the deviation of spherical projectiles.

Robins, Euler, Lombard, and other savants, have, without solving it, treated of the questions of the deviations which are caused in the flight of the spherical projectile, by the distance more or less observable between its centre of gravity and the centre of its figure. They have not agreed amongst themselves, and their opinions have been so far from a solution of the question, that the Commission of the year 1803 interpret them in one sense, whilst M. Poisson, in his Memoirs of 1838, gives a different one, and sometimes opposes those opinions; Hutton, in his experiments at Woolwich in 1796, remarked that a certain position of the projectile diminishes the deviations, but the English Artillery had kept that remark a secret; subsequently it endeavoured to derive advantage from it, and particularly in the practice of Sharpnell's shells; but the advantages derived by these means were not such as to cause attention.

In the year 1803, the report of the French experiments declared that "*shells with bottoms have a greater range than shells without bottoms,*" and again stated that "*shells with bottoms deviated no more than shells without bottoms,*" adding, however, these words, "an effect for which no reason can be given;" and in the voluminous work which was then printed, these different effects are spoken of, surprise is expressed, and they are variously explained; but, as a principle, it is laid down that the main cause is the vibrations within the piece. However, one important matter was then perceived (I am not aware that it was so for the first time), and M. Clement says that the irregularity of firing, as regards length of ranges, must be referred to the same cause which produces irregularities to the right or to the left; and in his work published in 1808, the same Officer, after studying the experiments of 1803, says at page 43: "The flight of a shell becomes longer and more regular, the greater is the distance of its centre of gravity from the centre of its figure." Every one thought at the time that this was a paradox; nevertheless, it was true. But M. Clement did not define what should be the respective position of the two centres in the fire-arm, and his principle, without a knowledge of that position would give, as will be seen hereafter, in the greater number of his experiments, results altogether different from those he expected to have obtained. In 1813, the English communicated Hutton's secret to the Prussians, who then had but little leisure to study the use of it, but subsequently they made some experiments and succeeded in a method by which the lateral deviations were diminished; they marked the shells with three red circles, so as to be enabled to place them in short howitzers in the described position. In 1826 and 1827, considerable experiments were made at Mayence, some of the effects of the eccentricity were tried and kept secret; but it would appear that only erroneous principles as to theory were established, and but little was done for practice. In 1828, some

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Austrian and Saxon Officers having witnessed the Prussian experiments, guessed the secret. In 1830, the Prussians imparted it to the Emperor of Russia, by whom experiments were ordered, and the Academician M. Ostrogratski was directed to study this question. In 1835, the method reached Belgium; experiments were conducted there with great skill and nicety. In 1837, a Prussian Officer having brought the system (still however limited to lateral deviations) to France, some trials were made at Vincennes. In 1839, that Officer published in Belgium the results; but neither the report made in France of the trials at Vincennes, nor the pamphlet published in Belgium, lead to the belief that the means had been established, nor that the true conditions of it were known, particularly as regards the range. In 1838, amongst ourselves we were so little agreed as to the causes of deviation, and of the *method* of avoiding them, that M. Poisson, Inspector of Artillery, a savant of the highest order, in his very elaborate Memoirs, thus expresses himself:—"The equations of the movements of a projectile are too complicated to be possibly able to deduce their approximate values from their unknown ones, sufficiently simple to be of any utility;" and he was forced to consider deviations, or their causes, to be very inconsiderable; yet, in practice, and particularly in hollow projectiles, they are often very great, and as to the distance between the centre of gravity and the centre of the figure, his theory did not ascribe to the distance any considerable influence, yet, practically, that influence, as will be hereafter seen, is a very decided one. Finally, he gave nothing which materially advanced the theory, and nothing of which practice might avail itself.

Such are the historical facts, let us now see the Balistic facts; the latter I will take at the moment when they have some value from the experiments made in Belgium. The result of these experiments (passing over useless details) were as follows, taking the mediums:

1stly. When the centre of gravity was above, the range was greater than when it was below, in the proportion of 2467 to 1315.

2ndly. When the centre of gravity was to the right or to the left, the shots went always to the right or to the left.

These experiments took place in Belgium between 1835 and 1840, with different calibres. With a howitzer-gun of the calibre of 150 (throwing the shell of 0^m, 27, horizontally), the distance being 1000 metres, by the *method* adverted to, the two first rounds exactly struck the centre of the target, and all the others at points very near to it.

These results appearing to me to be worthy of attention, in 1841 I asked and obtained permission to make some experiments at Metz, at the Polytechnic School there; the following are the principal results obtained by those experiments:—A 12-pr. field gun, with its charge, its shot and common bottom, at an angle of 4 degrees; again,

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with the same charge, the same bottom, and the same angle, but with a shot having an eccentric hollowing, so as to separate the centre of gravity from the centre of the figure, and which weighed 5 kilogrammes instead of 6; when the centre of gravity was placed on the right, the shots always went to the right; when the centre of gravity was placed on the left, the shots went always to the left; when the centre of gravity was placed at the bottom, the ranges were always short; when the centre of gravity was placed at the top, the ranges were always long; and the measures of the advantages obtained were as follows:—The medium range which, by the ordinary shot was 1500 metres, was by the new method 1900 metres, the increase was 400 metres. The mean deviations in the ordinary shot were 13-hundredths of the range, by the *method* they were only 8-hundredths, and the difference of range between the longest and the shortest, by the ordinary firing, was 276-hundredths, whilst by the *method* it was only 153 hundredths.

Here then assuredly were considerable improvements, both as to the correctness and length of range, and moreover a diminution of one-sixth in the weight of the projectile, which will considerably lighten the ammunition waggons. Similar results were obtained during these experiments, with the shell of $0^m,15$, whether with the small or great charge; and it may be seen in the tables of practice that, for example, with a charge of 1 kilogramme, and always at an angle of 4 degrees, firing in the ordinary manner, that the medium range was 1166 metres, whilst by the *method* it was 1605 metres, giving an increase of 439 metres; and the superiority of precision, as regards lateral deviations, was very great, for, by the ordinary firing, the medium deviation was 16-thousandths of the range, but by the *method* was only 2-thousandths, an almost mathematical precision. I must, however, acknowledge that, from some inexpressible anomaly in the precision of the rounds, as regards the equality of the ranges, the shots from this howitzer and this charge were more reciprocally equal without the *method*.

It may now be established, that the experiments conducted in England and in Germany having produced remarkable results, those results having been much improved by the experiments in Belgium, and these latter being confirmed by those made at Metz. There is in the distance of the centre of gravity, from the centre of the figure of spherical projectiles a condition, which formerly was the cause of deviation and of difference of range, and which condition may become the means of obtaining precision and uniformity of ranges, long or short, at pleasure. The *theory* of deviation, difficult, arduous, and incomprehensible as it has been, even for the savants, is rendered by these experiments simple, and perfectly demonstrated, and particularly, if not in all cases, at least in those of projectiles fired with care, advantages may be derived from these results, which may be most

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valuable. This Memoir was presented in 1841, but my proposal that attention should be given to the subject was not accepted. The following year I obtained from the Marine Department a trial of my howitzer-gun of 80, and an experiment was made, the result of which was that, at an angle of 10 degrees, with a charge of 6 kilogrammes the range was . . . . 2342 metres.
with same charge with the *method*, . . 2923 „
with a charge of 8 kilogarmmes and the *method*, 3236 „
Here then with the same charge, by the effect of the *method* only, the range was increased nearly 600 metres, and an increase of 894 metres by merely adding a little to the charge.

More recently, having obtained from the Marine Department in 1844, a trial of a gun without a chamber of the calibre 120, of the weight necessary for firing solid as well as hollow shot, this trial (which was successful) gave as the result, in reference to the question of the two centres and of the *method*, as follows (charge 9 kilogrammes, angle 10 degrees):—

range of solid shot, ... 2422 metres.
range of ordinary shell, . . . 2465 „
range of shell with the *method*, . . 2866 „
Here an addition of range was attained by employment of the *method* of 401 metres.

This *method*, therefore, is worthy of attention; assuredly, if means be discovered by which Artillery may be enabled to fire projectiles which are not spherical, possessing the precision and greater range which have been obtained for the new Musket (which question has been treated of in a former paper), the advantage to be obtained by the *method* for the correction of the effect of the two centres will be exceeded, and that *method* will have only served for the purpose of throwing light upon a theory which, to the present time, has remained obscure.

But so long as the Artillery, for want of better, is fixed to projectiles of a spherical form, I cannot understand why it should reject the employment of a method approved of by other nations, and which gives at once much greater lateral and longitudinal precision, and which, moreover, affords a certainty of obtaining with regularity the utmost extent of range.

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Abstract of the Accounts from 30th April, 1851, to 1st May, 1852.

Income.	£	s.	d.
Balance Cr. on 1st May, 1851, ...	202	16	2
Subscriptions, Annual, ...	144	1	0
Subscriptions, Entrance, .	14	10	0
Sale of Chemical Tables, ...	7	6	0
Dividend on £500 consols, ...	14	11	4
Printing, ...	29	0	6
	£412	5	0

Expenditure.	£	s.	d.
Books and Stationery, ...	24	12	10
Printing Rollers and Material,	1	11	8
Purchase of Large Fossil, ...	4	10	6
Insurance	5	1	3
Clerk's Salary, at 1s. per diem,...	18	6	0
Fuel and Incidentals,... ...	9	15	5
Unpaid Subscriptions, ...	1	7	6
Cleaning and Repairing Chronometer,	2	10	0
Assistance in Printing, ...	5	13	0
Printing Chemical Tables, ...	30	5	0
Clearing and Planting round the Observatory, ...	36	14	11
Balance Cr.	271	16	11
	£412	5	0

ANNUAL REPORT

For the Year ended 30th April, 1853, and extended to 1st October, 1853; read at a Special General Meeting, Oct. 10, 1853.

COL. WHINYATES, C.B., K.H., COMMANDANT, IN THE CHAIR.

THE Annual Meeting has been delayed from time to time, until the Committee could have the satisfaction of stating to the Regiment that the New Building was furnished and ready for use; and until they could also state that the Master General was desirous of affording such assistance as might be required, by permitting the officer to be named as Secretary to be taken off all regimental duty, for a period not exceeding three years. His Lordship has ordered this by a letter from the Deputy Adjutant General, dated 9th Sept., 1853.

Abstract of Accounts from 1st May, 1252, to 30th April, 1853.

Income.	L.	s.	d.
Balance Cr. on 1st May, 1852, ...	271	16	11
Subscriptions, Annual, ...	153	17	6
Subscriptions, Entrance, ...	54	10	0
Subscriptions, Back, ...	3	0	0
Dividends on £500 consols, ...	14	11	4
Printing, ...	7	8	7
Sale of Chemical Tables, ...	7	8	0
Repair of Instruments, ...	0	12	6
Back Subscription of French Class,	0	12	0
	£518	11	10

Expenditure.	L.	s.	d.
Books, Binding, and Ststtionery,	7	5	10
Purchase of Instruments, ...	62	17	6
Insurance, ...	5	1	3
Clerk's and Attendant's Salaries,	27	12	9
Fuel and Incidental Expenses,	12	15	8½
Unpaid Subscriptions, ...	1	17	6
Gratuity to Serjt. M'Kinlay, in consideration of printing, &c.	15	0	0
Furnishing and Fittings. ...	26	3	4
Power of Attorney for transfer of Stock, &c., ...	2	9	3
Proof Engraving of Professor Barlow, ...	2	2	0
Balance Cr.	350	6	8½
	£518	11	10

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Abstract of the Accounts from 1st May to 31st August, 1853, shewing the present state of the Funds.

Income.	£	s.	d.
Balance Cr. 1st May, 1853 ...	350	6	8½
Subscription, Annual, ...	148	2	6
Subscription, Entrance, ...	8	10	0
Subscription, Back, ...	1	15	0
Printing, ...	5	18	4
Consols, 3 per cent.	500	0	0
Gen Sir R. Gardiner for Microscope,	40	0	0
Building Fund, ...	674	3	6
	£1728	16	0½

Expenditure.	£	s.	d.
Furniture and Fittings, ...	483	2	0½
Books and Stationery, ...	6	2	0
Lithographic Press and Material,	34	15	4
Incidental Expenses	2	7	9
Salaries, Non-Comd. Officer,	15	7	6
Salaries, Gunner, ...	3	1	6
Balance. ...	1183	19	11
	£1728	16	0½

The Meeting is aware that exertions have been for some time made to place the Institution in a position of greater usefulness, not only to officers on the spot, but to those away from Woolwich; and the Committee can not but congratulate the Corps at having arrived at such a position.

The Building has been handed over to the Committee by order of the Master General, in a state requiring but few alterations, and has been furnished by them in a manner sufficient for present purposes; any alterations or additions can be made at a future day.

On the motion of the Committee, the Master General and Board have been pleased to defray the expenses of the gas-fittings, amounting to £71 11s. 4d., thus saving that sum for the present use of the Institution.

The erection of the Building by Her Majesty's Government might, perhaps, be thought to alter, in a slight degree, the character of the Institution, but the Committee is of opinion, that its working and arrangements are still understood to be in the hands of the Members, and that the preamble originally drawn up still points out its true character.

The Committee is of opinion, that the uses of the Institution must be left to develope themselves as cases arise, and that no good result will follow from urging them beyond what is required, or of beginning on too extended a scale. The object has always been to provide means of self-improvement; the liberality of the Master General and Board has carried this somewhat farther, by providing for regular instruction in languages, and the Institution may probably pursue the same course, by providing from its own funds regular instructors in other subjects. But it has always rested, and must continue to rest mainly with officers, individually, to agree on their own arrangements for taking advantage of these opportunities.

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It has appeared to the Committee on a careful consideration of the objects of the Institution, as stated in the preamble to the regulations, that it (the Institution) is a voluntary association, supported by voluntary contributions, established for the purpose of affording instruction and information to the officers of the regiment, on all subjects of professional and scientific interest, among which they would name the following subjects as capable of being carried out, in addition to any relating to the advancement of strictly professional knowledge:—Practical Instruction in Modern Languages; in Veterinary Science; the Use of Instruments for Surveying, or Astronomy; Lectures and Manipulation in Chemistry; Lectures on Mineralogy and Geology. In addition to which the possession of so large and convenient a building will furnish opportunities for cultivating pursuits of taste or utility, which require greater accommodation than a barrack room affords, as Music, Drawing, Photography, Lithography, Wood-cutting, Taxidermy, and many others.

The extended sphere of usefulness which opens before the Institution, appears to the Committee to require some modification of the existing Regulations, and they append a memorandum which they have drawn up on the subject, to be printed with the Report and submitted to the consideration of the Members generally.

The specific changes in the Regulations which are contemplated, are before the Meeting and will be put to the vote in the usual way.

With regard to the increased rate of Subscription, the Committee is most anxious that every Member, at every station, either at home or abroad, and those retired from the service, should participate in the increased advantages of the establishment, by receiving periodically, Printed Papers of Proceedings, containing Abstracts of Lectures, and communications on Professional and other subjects, and, under certain regulations, assistance in forming classes for the study of languages.

Since the last Annual Meeting the following changes have taken place in the Committee, in consequence of officers leaving the garrison, and from the death of one of the most distinguished officers of the corps:—

Col. Dundas,	Lt. Col. Wilford,
Lieut. Bayly,	" Thorndike,
Capt. Smythe,	Col. Colquhoun, *deceased.*

To supply their place the Committee elected according to Rule VII.,

Lt. Col. Pickering,	Lieut. Yates,
Captain Dixon,	Lt. Col. Tulloh.
Lt. Col. J. A. Wilson,	

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The following retire by rotation according to Rule VI.:—

Dr. Stewart,	Capt. Clerk,
Capt. Brandling,	„ Bent.

In consideration of the new basis on which the Institution is now placed as regards its Rules, and particularly in relation to the enlargement of the Committee, the remaining Members of the Committee think it desirable that the Meeting should have the satisfaction of making such arrangements in this respect as they may require; they, therefore, beg to restore to the Meeting the trust committed to them when elected to serve on the Committee.

In April, 1852, circulars were sent to all non-subscribers, 62 in number, of whom 36 became Members, leaving 26 non-subscribers at that period; at the present time they amount to 31; also to all non-subscribers of the Ordnance Medical Department, when 12 joined.

Proposed by Captain RIDDELL, *seconded by Lt. Col.* FLUDE, *and carried:—*

That the Report be received and printed, without the Minute of the Committee setting forth their views of what is desirable for the future organization of the Royal Artillery Institution.

Due notice having been given, in accordance with Rule XVII, the following alterations were submitted by the Committee:—

Proposed by the Committee, and carried:—

To leave out the words " entrance and" in Rule I.

Proposed by the Committee, and carried:—

That the words " without payment" be added to Rule II.

Proposed by the Committee, and carried.

That Rule III. stand thus—" The Annual Subscription of the several ranks shall be as follows:—

General Officers,	*ad lib.*
Regimental, Field, and Superior Officers,	£1 5 0
Captains,	0 16 0
First Lieutenants,	0 10 0

Proposed by 2nd Lt. BETTY, *seconded by 2nd Lt.* L'ESTRANGE, *and carried:—*

That there be a lower rate of subscription for 2nd Lieutenants, viz., 8s. per annum.

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Proposed by the Committee, and carried:—

To cancel Rule IV. and substitute—"That the Master General be requested to be the Patron and President of the Institution; That the Deputy Adjutant General, the Director General of Artillery, and the Commandant of the Garrison, be Vice-Presidents. That the affairs of the Institution be under the direction of a Committee consisting of The Assistant Adjutant General, The Assistant Director General of Artillery, The Brigade Major, and of fifteen Officers, elected at the Annual General Meeting, of whom four shall be Colonels, or Regimental Field Officers, and one Medical Officer; one Colonel, or Field Officer, and four Members to retire annually, and one Medical Officer every two years; and none of these to be eligible for re-election until the expiration of one year after leaving office.

Proposed by the Committee, and carried:—

That a Secretary, having a vote at the Committee, be selected by the Committee from the Corps at large, to be named to the Deputy Adjutant General, and with his approval submitted to the Master General. That an Assistant Secretary be selected by the Committee from among the officers doing duty at Woolwich, not necessarily to be a Member of the Committee, but if not, to vote for, and in the absence of the Secretary.

Proposed by the Committee, and carried:—

To cause Rule XV. to run thus—"A Meeting of the Committee to take place at one o'clock, on the first Thursday in each month, or on such other days as the Committee shall appoint; five to form a quorum, the senior officer to take chair."

Proposed and carried unanimously:—

That the following officers who have voluntarily resigned, be re-elected to serve on the new Committee:—

Lt. Col. J. A. Wilson,	Capt. Dixon,
" Tulloh,	Lieut. Yates,

Proposed and carried unanimously:—

The following Members be elected to the Committee, according to Rule IV.:—

Lt. Col. Flude,	Captain Henry,
" Lake,	Lieut. Fraser,
Captain Price,	" Warlow,
" Boxer,	" C. F. Young,
" Strange,	Dr. Savage.
" Gordon,	

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On conclusion of the business of the day, the Chairman proposed the Thanks of the General Meeting to Capt. F. Eardley-Wilmot, for his constancy in promoting the interests of the Royal Artillery Institution, from its origin to the present day; and for the zeal and ability he has displayed in conducting its affairs, not unfrequently under great discouragement, his persistency of purpose, and application of time and labour to this object during the whole period of his Secretaryship, the effective results of which are manifest in the state of the building, and the facilities it already possesses for the acquisition of professional knowledge and science—the study of languages—the cultivation of the fine arts, and of those pursuits,—which in connection with military subjects in particular, and with knowledge generally, will extend the usefulness of the corps to the service, and the country.

DONATIONS.

LIEUT. COL. EYRE.—4 Specimens of the Monkey kind, 1 Vampire Bat, 2 Lizards, 61 Birds, 6 Bats, 4 Quadrupeds, 9 Minerals. [*From China; very rare.*]

LIEUT. COCKBURN.—6 Specimens of Canadian Birds; collection of Fossils. [*Isle of Sheppy.*]

LIEUT. ORME.—1 Shell of Tortoise; 1 Stuffed Fish; 2 Frogs; 1 Iguana. [*Barbadoes.*]

CAPT. GRAYDON.—Collection of Fossils and Minerals.

CAPT. DALTON.—Aide Memoir of the Military Sciences, vols. 1 and 2; Bousmard on Fortification, 5 vols.

CAPT. O'BRIEN.—Kausler's Military Work, 2 vols.

His Grace the DUKE OF NORTHUMBERLAND.—Report on Model Life Boats.

PROFESSOR HALL of New York.—Natural History of New York, (Palæontology,) 2 vols.

CAPT. GREY.—Shark's Jaws, Skin, and Backbone; part of Saw Fish; 2 Calabashes; 6 Pamphlets; 2 small Animals preserved in spirits of wine. [*West Indies.*]

MAJOR GEN. CAMPBELL.—Journal of Siege of Gibraltar, (M.S.)

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CAPT. GRIFFITHS.—Artillerist's Manual, 2nd edition.

MAJOR C. YOUNG.—Pamphlet on the Indian Artillery.

MRS. LACY.—Curious Reading Desk, cut out of one piece of wood; 3 Greek Knives; several specimens of West Indian Wood and Fossils; part of the wreck of the Mary Rose; Braidwood on Fire Engines; The Law of Evidence, 1801; The Little Sea Torch; 1801; Iconographie des hommes illustres, Antonio Van Dyck, 1 vol. folio.

LIEUT. COL. WILLIS.—United States Ordnance Manual.

CAPT. CHERMSIDE.—20 specimens of Metallic Ores ; 2 Snakes; 6 Fossil Shells; 62 specimens of ancient Stone Weapons.—[*Island of St. Vincent.*]

CAPT. LITTLE, (*Madras Horse Artillery.*)—13 Volumes of Madras Artillery Records.

LIEUT. D. JONES.—Nautical Almanack for 1855; 2 models of Cingalese Boats.

CAPT. E. FLINT.—2 Boxes of Minerals; 1 of Shells; 3 ancient Swords; Fucus from the Gulph Stream.

LIEUT. GOODENOUGH.—2 Birds from Halifax.

LIEUT. SINGLETON.—2 Brain Stones. [*Bermuda.*]

CAPT. DESCHAMPS.—Views of Ceylon.

SIR R. GARDINER.—Microscope and Apparatus, (£40.)

CAPT. LEFROY.—Canadian Fox; Pamphlet on the probable number of the Native Indian population of British America.

MESSRS. TROUGHTON AND SIMMS.—Treatise on the Equatorial Telescope.

CAPT. YOUNGHUSBAND.—Collection of Minerals.

DR. STAUNTON.—Aide Memoire des Officiers d'Artillerie; D'Anville Memoir sur la Caspienne; Lunemann's Caucasus; Ligny und Belle Alliance.

BOARD OF ORDNANCE.—Ordnance Survey; Roman Pottery, found in the Arsenal.

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CAPT. OWEN, R.E.—Mineral Specimen.

LT. COL. WILSON.—Specimens of Wood. [*Ceylon.*]

CAPT. CONNELL.—Collection of Minerals.

CAPT. MACLEAN.—Collection of Minerals. [*Hong Kong.*]

MR. TENNANT.—Chart of Fossil remains.

THE AUTHOR.—Fieling's German Guide, and German Course.

The Executors of the late COL. COLQUHOUN.—2 Pictures; a large collection of Minerals; Rocket Apparatus for killing Whales; Manœuvres et les Evolutions des Batteries Attelées; Essai Murs de Revêtement.

It may be added, that there has been for the present deposited in the Institution, for the use of the Members, by Captain Lefroy, executor of the late Capt. Augustus Fraser, and with the cordial concurrence of his family, many valuable Maps, formerly belonging to the late Sir Augustus Fraser.

PURCHASED.

Instruments, &c.

24-Inch Plate Electrical Machine.
Double-barrelled Air Pump and Apparatus.
5 Prismatic Compasses.
Large Lithographic Press.
Turning Lathe and Tools.
Carpenter's Bench and Tools.
Shot Guage and Callipers.

Books, &c.

Dixon's Geology of Sussex.
Glashier's Hygrometrical Tables.
Liebeg's and Kopp's Report on Chemistry, 4 vols.
Printer's Every-day Book.
Manual of Lithography.
Faraday's Lectures on the Non-metallic Elements.
On Ellectrical Illumination.
Barlow on Strength of Materials.
Jeffers' Naval Gunnery.
Holtzapffel's Turning and Mechanical Manipulation.

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Steam Ship capability.
Rumford's Philosophical Papers.
Mosley on Mechanics as applied to the Arts.
Mosley's Illustrations of Mechanics.
Treatise on Mechanics, by Capt. Kater.
Steam and Steam Navigation, by Russell.
Treatise on Railways, by Lt. Lecount.
Mrs. Somerville on the Physical Sciences.
Pursuit of Knowledge under Difficulties.
Natural Magic.
Williams on the Combustion of Coal.
Armstrong on Steam Engine Boilers.
Circumnavigation of the Globe, by Capt. Cook.
Lives of Eminent Zoologists.
Smee's Metallurgy.
White on the Natural History of Selborne.
Popular Introduction to Natural History.
Jones's Journal of Sieges, 2 vols.
Siborne's History of the Waterloo Campaigns, 2 vols.
Large Fossil (Icthyosaurus.)

DONATION LIST.

9th November, 1849.

The undermentioned, being duly impressed with the importance of affording all Officers of Artillery opportunity to carry on their professional education, and being convinced that the provision of suitable accommodation for assembly to hear lectures, &c., would be a great step towards this object, are of opinion that the Institution is the legitimate ground on which such an advance may be made; they therefore, agree to use their endeavours for the erection of a new building on a suitable site, to be appropriated to the Royal Artillery Institution, and in furtherance of this object subscribe the following sums.

Generals.	£	*s.*	*Colonels.*	£	*s.*
Gardner, Hon. W.B., *l. g.*	3	0	Whinyates, . .	100	0
Tobin, *l. g.* .	5	0	Campbell, F. .	1	0
Birch, *m. g.* . .	20	0	Jones, I. E. .	1	0
Downman, Sir T., *l. g.*	5	0	Jones, W. D. .	1	0
Ross, Sir H. D., *l. g.*	10	0	Russell, .	2	0
Campbell, P., *m. g.*	5	0	Dansey, . .	10	0
Macdonald, *m. g.* .	2	0	Michell, .	1	0
Parker, *m. g.* .	10	0	Scott, . .	1	0
Armstrong, *m. g.* .	2	0	Cobbe, . .	1	0
Brough, *l. g.* .	2	0	Roberts, . .	1	0
Gardiner, Sir R., *l. g.*	40	0*	Cruttenden, .	1	0
Evelegh, *l. g.* .	5	0			

* For the purchase of a Microscope.

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	£	s.
Chester,	2	0
Wallace,	1	0
Turner,	5	0
Browne,	5	0
Maclachlan,	5	0
R. Jones,	1	0
Dyneley,	1	0
Cator,	10	0
Gordon, J.	1	1
Dundas,	10	0
Bastard,	1	0
Lieut.-Colonels.		
Chalmer,	2	0
Bell,	5	0
Brereton,	10	0
Anderson,	1	0
Evans,	1	0
Colquhoun,	10	0
Wright,	1	0
Bent,	1	0
Story,	1	0
James,	5	0
Macbean, A.	1	0
Tomkyns,	5	0
Garstin,	1	0
Williams,	1	0
Louis,	1	0
Palliser,	2	0
Rowland,	5	0
Bloomfield,	3	0
Romer,	1	0
Gordon, C. E.	5	0
Strangways,	2	0
Chesney,	1	0
Cater,	1	0
Burnaby, R. B.	1	0
Stopford Blair,	5	0
Walker,	1	0
Hanwell,	1	0
Belson,	2	0
Haultain,	1	0
Armstrong,	2	0
Lock,	1	0
Cuppage,	1	0
Willis, (annually for 5 yrs)	1	0
Otway,	2	0
Grantham,	3	0

	£	s.
Bayly,	1	0
Tulloh,	1	0
Warde,	2	0
Majors.		
Dupuis,	1	0
Dickson, C.	1	0
Spencer, Hon. R.	2	0
Rowan,	1	0
Bridges,	5	0
Askwith,	2	0
Gostling,	1	0
Desbrisay,	1	0
Thorndike,	2	0
Eardley-Wilmot, H.	1	0
Captains.		
Wood,	8	0
Fyers,	10	0
Forbes,	1	10
Tylden,	1	0
Teesdale,	1	0
Wingfield,	2	0
Grant,	5	0
Eardley-Wilmot, F.	10	0
Townsend,	1	0
Beresford,	1	0
Warde, E. C.	5	0
Bingham,	2	0
Warburton,	2	0
Smythe,	10	0
Hamilton, A. G. W.	1	0
Crawford, R.	5	0
Wright,	1	0
Goodenough,	2	0
Graydon,	1	0
Cannon,	1	0
D'Aguilar,	2	0
Dixon, W. M.	1	0
Adye, I. M.	1	0
Cox,	1	0
Domville, J. W.	1	0
Maberly,	10	0
Brandling,	1	0
Maude,	1	0
Devereux, Hon. G.	1	0
Radcliffe,	1	0
Pack,	2	0
Riddell,	10	0

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	£	s.
Mountain,	1	0
Franklin,	1	0
Henry, C. T.	1	0
Anderson,	1	0
Boxer,	1	0
St. George,	1	0
Marriott,	1	0
Younghusband,	1	0
Ward, F. B.	1	0
Harison,	1	0
Griffiths,	1	0
Lindsay,	1	0
Cocks,	3	0
Patton,	1	0
Gibbon,	1	0
Cockburn,	1	0
Brettingham,	1	0
Wynne, J.	1	0
Evelegh,	1	0
Aylmer,	1	0
Irving,	1	0
Barker,	2	0
Lempriere,	2	0
Gosset,	1	0
Mottley,	1	0
Runnacles,	2	0
Mitchell,	1	0
Poole,	1	0
Montresor,	1	0
Thomas,	1	0
Green,	1	0
Toriano,	1	0
Innes,	1	0
Ellis,	1	0
Philpotts,	1	0
Ayde, M.	1	0
Cleveland, S.	1	0
Hill,	1	0
Elgee,	1	0
Pickering,	1	0
Chapman,	2	0
Poole,	3	0
Stokes,	0	12
Nixon,	1	0
Wodehouse, F.	1	0
Burrows,	1	0
Lawrence,	1	0
Fennick,	1	0
Papillon,	3	0
Poulden,	2	0
Strange, H. F.	5	0
Clerk,	1	0
Rogers,	1	0
Cator,	2	0
Crawford, W.	1	0
Dixon, M. C.	1	1
Skinner,	2	2
Sandham,	1	0
Haultain,	1	0
Maclean. P.	1	0
Nedham,	1	0
Walker,	1	0
Dennis,	1	0
Childs,	1	0
Travers, J.	1	0
M'Coy,	1	0
Dick,	1	0
Allen,	1	0
Elliott,	1	0
Turner, H. A.	0	10
Tylee,	1	0
Gardner, W. B.	1	0
Christie,	1	0
M'Queen,	1	0
Hawkins,	1	0
Johnson,	1	0
Connell,	1	0
Campbell, H. A.	2	0
Lefroy,	10	0
Hamilton, F. S.	1	0
Bathurst,	1	0
Domvile, J. R.	1	0

Lieutenants.

Parkin,	1	0
Biddulph,	2	0
Freeling,	1	0
L'Estrange, P. W.	1	0
Ferrers,	1	0
Morris,	1	0
Curtis,	1	0
Gordon, S. E.	1	0
Stewart,	1	0
Burtchael,	1	0
Telfer,	2	0
Paget,	1	0

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	£	s.
FitzHugh,	1	0
Glanville,	1	0
Boothby,	1	0
Lambert,	1	0
Moubray,	1	0
Milman, G. H. L.	1	0
Milward,	1	0
Boultbee,	1	0
Dickson, P.	1	0
De Havilland,	1	0
Calvert,	1	0
Shakespear, J. D.	1	0
Lukin,	1	0
Dumaresq,	1	0
Gabbett,	1	0
Rotton,	1	0
Owen,	0	10
Ommanney,	1	0
Greene, D. S.	1	0
Sinclair,	1	0
Addington, Hon. L.	1	0
Garvey,	1	0
Carpenter,	1	0
King,	2	0
Tupper,	1	0
Gage, Hon. E. T.	1	0
Hamley,	1	0
Godby,	1	0
Taylor,	1	0
Reilly,	1	0
Vernon,	1	0
Phillips, P. W.	1	0
Bent,	1	0
Warlow,	1	0
Ingilby,	1	0
MacKenzie,	1	0
Haig,	1	0
Higgins,	1	0
Crawford,	1	0
Barstow,	1	0
Taswell,	1	0
Leslie,	1	0
Bayly,	1	0
Standish,	1	0
Field, G. T.	1	0
Denne,	1	0
Orme,	5	0
East,	1	0
Colclough,	1	0
Barry,	1	0
Vandeleur,	1	0
Soady,	1	1
Freeth,	1	0
Ellis, Hon. A.	1	0
Henry,	1	0
Grey,	2	0
Johnston, C.	1	0
Arbuthnot,	1	0
Blair,	1	0
Kennedy, Lord W.	1	0
Murray,	1	0
Chermside,	1	0
Orr,	1	0
Jones, R. P.	1	0
L'Estrange, G.	1	0
Forbes,	0	10
Boulton, J.	0	10
Bruce,	0	10
Boyle,	0	10
Heberden,	0	10
Noble,	0	10
Wilson, J. W.	2	0
Margesson,	3	0
Gleig,	1	0
MacDougall,	0	6
Pigou,	0	6
Hastings,	0	6
Colomb,	0	6
Farmer,	0	6
Dames,	0	5
Rowley,	0	5
Seymour,	0	6
Hay,	0	6
Hope,	1	0

Medical Officers.

Webb, Sir John,	5	0	0
Parratt, Surg.	1	0	0
Thomas, Inspector,	1	0	0
Ogilvie, Surg.	1	0	0
Walshe, Asst.-Surg.	0	10	0
Stewart, Surg.	5	0	0
Gilborne, Asst.-Surg.	0	7	6
Williams, Surg	3	0	0

Chaplain.

Scott, Rev. Mr.	1	0	0
	£714	3	6

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ANNUAL REPORT

For the Year ending 30*th March*, 1854; *read at a General Meeting, held on Friday, June* 30*th*, 1854.

LIEUT.-COLONEL BLOOMFIELD, R.H.A., IN THE CHAIR.

Since the adjourned Annual Meeting, held October 10th, 1853, the Committee has taken steps to collect the votes of Members of the Institution at out-stations, with respect to the proposition for increasing the rate of Annual Subscription, which was brought forward by them, and carried unanimously at the General Meeting upon that occasion.

Answers to the Circular of the Committee, dated October, 1853, have been received from the whole of the Home Stations, and from all the Foreign Stations, with the exception of Corfu—Mauritius—Ceylon—New Zealand.

The number of votes recorded, is as follows:—

At the General Meeting,		53
Verbal Communication,		76
Individually by Letter.	Colonels,	17
	Others,	30
By Returns from	Home Stations,	178
	Foreign Ditto,	114
Chaplain, and Medical Officers,		7
		475

Of this number 458 assent, and only 17 dissent from the measure.

The total number of Members of the Institution, exclusive of General Officers, who are not affected by the increase of Subscriptions, is 600; consequently, a large majority on the whole vote is already obtained in favour of the increase. Of the 125 Members,

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whose votes are not yet collected, 28 are at stations not heard from, the remainder are supposed to have been on leave, or out of the way, when the circular was received at their station. Nearly all of them have been written to.

The Committee will presently propose a Resolution to declare the increased rate of Subscription to be carried; and to authorize the Agents to charge it for the current year, to all Members of the Institution, who have agreed to the measure, or who may agree by replies yet to be received.

With regard to those Officers who have voted against the increase of Subscription, the Committee proposes to write to them again, informing them of the decision of the majority of the Members; and fully expects the pleasure of reporting to the next Meeting, that the objections, many of which are conditional, have all been withdrawn.

The Committee has great pleasure in announcing to the Members, that His Lordship the Master General, has kindly consented to be named the President of the Institution, at the same time becoming an Annual Subscriber of £5. It is to His Lordship's favourable recommendation, that the Committee owes the power of communicating the following letter from the Board of Ordnance, nor can they express too strongly their sense of the advantage which the Institution may hope to derive, from the selection of an Officer among the Members of the Institution, and his appointment by the Master General, with a stipulated salary, to perform the onerous duties which devolve on the Secretary.

T.
10*th April*, 1854, 259.

The Lords of the Treasury have sanctioned the payment of a Salary of 7*s.* a-day, to the Secretary of the Royal Artillery Institution, on condition that no further grant of money in any shape or any pretence is applied for.

The appointment of Secretary is to be absolutely in the Master General's hands, and the condition of the payment of the Secretary is, that the Institution undertakes to provide all that is necessary to make it work well, from private contributions.

(Signed) J. Wood, Secretary.

The following is an abstract of the Accounts of the Institution for the past year, showing a balance in favour of the Institution of £290 3*s.* 8*d.*; together with £500 invested in Consols.

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GENERAL ABSTRACT OF THE INCOME AND DISBURSEMENTS OF THE ROYAL ARTILLERY INSTITUTION FOR THE YEAR 1853-4.

INCOME.				DISBURSEMENTS.			
By Balance Cr. 1st May, 1853,	£850	6	8½	Furniture and Fittings,	£582	12	10½
Subscriptions, Annual	167	10	0	Printing, Lithographic Press and Materials,	40	8	7
Subscriptions, Entrance	8	10	0	Printing, Printing paper,	12	3	4
Donations for Building and other purposes	718	3	6	Printing, Printers' wages,	6	18	6
Subscriptions towards refreshments at the opening of the Institution on 2nd March,	9	0	6	Lectures and Instructors,	41	8	0
Dividends on £500 Consols,	14	11	4	Instruments, and repairs of Instruments,	19	1	6
Discount allowed on Furniture bill,	12	7	0	Books, Binding, and Prints,	114	13	6
Sale of Chemical Tables,	6	2	0	Stationery,	10	0	4
Receipts by Printing,	23	12	7	Chemical Stock for Laboratory,	104	0	0
Receipts by Classes, Drawing Instruction, £16 10 0				Turning Lathes, Carpenters tools, &c.	68	17	11
„ Materials, 3 10 2				Salary of Clerk,	41	17	6
Chemical Instruction, 14 6 6				„ Cleaners and Orderlies,	9	7	0
„ Materials, 9 14 3	44	0	11	Transcribing "Records of the Regiment,"	3	10	3
Sale of fancy turning woods,	6	6		Drawing Materials,	3	4	8
„ Photographic Materials,	1	6	3	Plaster casts of Figures,	6	12	0
				Occasional purchases for the Museum,	3	11	6
				Insurance of Observatory (£1350)	5	1	3
				Repairs and alterations in Observatory grounds,	10	6	2½
				Refreshments at opening of the Institution on 2nd March,	10	0	0
				Special train to London on the above occasion,	3	5	0
				Unpaid Subscriptions, and Entrance fees refunded,	4	10	0
				Incidental expenses, (Postage, Carriage, &c.)	14	3	8½
				Balance Cr.	290	3	8
	£1355	17	3½		£1355	17	3½

(Signed) J. H. LEFROY, Captain, R. A.,
Secretary and Treasurer.

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The preparations in the Garrison for active service, and the constant changes resulting from those preparations, have caused a falling off since the middle of February, in the general attendance at the Institution. The classes in the German and French Languages, and in Drawing, have, however, been steadily maintained; the class in Analytical Chemistry was broken up in February, and has not yet been re-constituted.* Since the opening of the present building, the total number of Officers attending has been as follows:—

German Class, . . .	28	Drawing Class, . . .	24
French Class, . . .	29	Chemistry, ...	14

Several Officers have applied for, and have received from the Secretary, and from Capt. Dixon, instruction individually, in the use of Instruments for sketching in the Field, and in other matters of practice. The Committee must also here acknowledge the kindness of Capt. Scott, R. E., Instructor in Surveying, at the Royal Military Academy, who has at all times been ready to give the benefit of instruction to Officers desirous of it.

The following is a list of the Lectures delivered at the Institution since the opening:—

LIST OF LECTURES.

Col. Sabine,.....Introductory.
Capt. Boxer,.....Retrospect of the Science of Gunnery, I.
Mr. Abel,.. .....Chemistry of Pyrotechnics, I.
Capt. Lefroy,.....The Regimental Society of 1772—5.
Mr. Abel,.....Pyrotechnics, II.
Capt. Dixon,.....The changes of Tactics, resulting from increasing the Range of Projectile Arms at various periods of History.
Mr. Abel,.....Chemistry of Metallurgy, I.
Capt. Boxer,.....Science of Gunnery, II.
Mr. Abel,.....Metallurgy, II.
Lieut.-Col. Adair,.....Application of Militia Forces in the Defence
Suffolk Militia Art..... of Great Britain.
Mr. Abel,.....Metallurgy, III.
Capt. Lefroy,..... ...On the construction of Batteries, &c., from a MS., by Major Griffith Williams.
Mr. Abel,.....Metallurgy, IV.
Lieut.-Col. Portlock, R.E., on Geology, with local application to the Military Stations, I.
Mr. Abel,.....Metallurgy, V.
Mr. Abel,.....Metallurgy, VI.
Lieut.-Col. Portlock, R.E., Geology, II.

* A Class has been formed since the date of this Report.

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Considerable additions have been made to the Museum, especially in the department of Geology and Natural History; the presents of Lieut. Richards of a small collection of exceedingly choice and valuable specimens of Minerals—of Lieut. Griffin of a collection of 550 specimens from Nova-Scotia and New Brunswick, being a very complete illustration of the Mineralogy of these Colonies—of Dr. Bossey, of Woolwich, of Fossil remains, chiefly of the Elephant, from the neighbourhood of Woolwich—of the Director General of the Medical Department of the Navy, of a large collection in Natural History, and of Capt. Biddulph, Lieut. Griffin, and Mr. Delafield, of specimens of Birds, are very valuable acquisitions; but these are but a few of the principal donations, all of which call for the thanks of the Meeting.

The Committee are under great obligations to Lieut. Griffin, and Lieut. Cockburn, R. A., for devoting much time to the arrangement of the collection of Mineralogy and Geology. There are now about 1600 specimens of the former, and about 600 of the latter, besides 11 drawers of Minerals, chiefly duplicates, partially arranged, and a large number of Fossils distributed, but not arranged. It cannot but be gratifying to the meeting to learn, that the collection of Silver Ores from Mexico, presented by the family of the late Colonel Colquhoun, and acknowledged in the last Annual Report, has been pronounced by Mr. Tennant, to be among the most valuable and complete collections of that Mineral with which he is acquainted.

The thanks of the Committee are also due to Mr. Lovell Reeve, and Mr. Tennant, for assistance in the Museum.

The Committee has made an arrangement with Mr. Whitely to attend to the preservation of the objects in Natural History, until the collection is large enough for a beginning of arrangement, and may take the occasion of remarking, that to whatever extent the formation of a Museum of Geology, Mineralogy, or Natural History, may be carried, a scientific arrangement, and entire accuracy in naming and labelling specimens is very essential. A heterogeneous collection of objects, without order, imperfectly, sometimes inaccurately described, and perhaps including specimens unsuitable to a Museum of character, would not be creditable to the Corps, or calculated to promote the objects of the Institution in this department. The Committee, therefore, proposes to avail itself of professional and responsible assistance wherever it may be necessary, in getting donations labelled and classified; convinced, that although such assistance is usually highly paid, it is well worth while to incur any expense necessary to make the Museum a thoroughly good one within its special limits.

It is scarcely necessary to add, that hitherto nothing more has been done in the department of Natural History than to put away

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objects as they have been received, nor is there yet enough in the room for a beginning to be made in disposing of them.

The Committee have pleasure in announcing their prospect of very soon distributing among the Members, a small volume, containing information and data, which they think will be generally acceptable to the Corps, and to all military men, particularly at the present moment. This Work has been undertaken, and edited by Capt. Lefroy, assisted by some other Officers, with a view to what he considered would supply a want felt by most Officers—a real *Pocket Book* of reference. Capt. Lefroy having, in the most handsome manner, offered the result of his labour to the Institution. The Committee, have thankfully accepted it as a contribution to their proceedings. It is now printed, and copies are on the table, and it will be issued to all members as soon as possible.

The Committee have given much consideration to the whole question of Publication, which is rendered particularly important, by the probability, that so long as a state of war lasts, the unsettled state of the Garrison, at Woolwich, will interfere more or less with other fields of usefulness open to the Institution.

In respect to the matter of Publication, the Committee is of opinion, that while the separation of the Officers of the Regiment upon detached commands, and the length of time many of them are absent from head-quarters, makes it important to circulate current information relating to the service, through the medium of professional papers; there is another direction, scarcely inferior in either interest or utility, which any special Publication of the Regimental Institution, may very feasibly take. It has long been a matter of surprize and regret, that the Records of the Regiment are unpublished. The collection made, during the several years, by the late Colonel Cleaveland, has already, with the greatest liberality, been offered to the Institution by his sons. Capt. S. Cleaveland's letter is appended. To this it may be added, that the whole of the very extensive Manuscript collections of the late Sir Augustus Frazer, are in the hands of the Committee, as are also a considerable portion of those left by the late Colonel Colquhoun; the former cover more or less the whole period from 1762 to 1830; access has been offered to the Manuscripts of others of the most distinguished Officers of the last war. Historical materials therefore exist in considerable abundance, and will doubtless accumulate when a beginning has been made in collating them. The Committee deem it well worthy of the efforts of this Institution to preserve, in this manner, the memory, which is now so soon lost, of the gallant services of Officers to whom the Regiment mainly owes its character, and to render the lessons of

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their experience available for the guidance or instruction of their successors.

The adoption of this class of subjects generally, will not prevent the Committee from bringing out, as far as the funds of the Institution permit, papers upon other subjects, some of which are in preparation; and an Officer of known historical research, has proposed, by a letter, also appended to this Report, to commit to the Publication of the Committee an historical work on the early History of Artillery, which proposal is under consideration. Having decided, however, upon the adoption of the arrangements for printing, patented by Major Beniowski, the Committee is unwilling to make the considerable additions to the present printing stock which any large undertaking will require. Indeed, it is doubtful whether, in respect to large works, it will not be better to have recourse to a publisher, who could generally be found willing to bring out any work of real value for the inducement of a certain order for a large part of the impression.

Experience has fully demonstrated the great convenience of the printing press of the Institution, which has been in constant work for the Garrison; so much so, as to have obliged the postponement of work for the Institution, until some previous engagements were completed.

The Committee desires to take this occasion of bringing before the Meeting a question, which has been mooted as to the form of Publication.

The question is, shall the practice be continued of printing an impression of 1000 copies of all papers, being one for every Member, with a stock for future demands, or shall the principle be adopted of printing for Libraries and Stations only, and not for individuals?

All continuous serial publication, is undoubtedly attended with the inconvenience of becoming, in course of time, too bulky for military use; and as Officers of Artillery are, as a general rule, attached to certain fixed and permanent stations, it has been suggested to the Committee, that every purpose of information might be answered if one, two, or in some cases, three copies of any large work were sent to each station, and an abstract in a smaller form, prepared for the use of members individually, after the manner of the proceedings of Scientific Societies.

The Committee have given this question consideration, and allude to it here, as the time will doubtless arrive when, if Publication is

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made one of the leading operations of the Institntion, it will have to be decided upon: but for the present, they are of opinion that the practice of furnishing every member with all the papers printed, had better be adhered to.

Advantage has been taken of the accommodation of the present building to attempt the formation of a complete collection of the Portraits of distinguished men, who have held high offices in the Ordnance from the earliest period.

The following noblemen have already, in the kindest manner, met the wishes of the Committee, by presenting Engravings or Pictures of Ancestors of their own included in the list.

The Duke of Marlborough.	The Duke of Rutland.
The Duke of Richmond.	Lord Braybrooke.

And it is hoped that no difficulty will be found in completing a series so appropriate to the Institution.

The design includes the Portraits of distinguished Officers of Artillery, Professors and Masters of the Royal Military Academy, and generally of all those in whom the Corps may justly feel a pride or a professional interest. A bust of the late Dr. Gregory, presented by his family, will be viewed by all Officers who remember that excellent man, with a warm interest, in connection with this design.

In compliance with Rule IV. of the revised Regulations, the following Officers retire from the Committee, and are not eligible for re-election.

Lieut.-Col. J. A. Wilson.	Capt. Fraser.
Capt. Warlow.	

The following Members have also left the Garrison, and their places have been supplied by the Committee, subject to the approval of the General Meeting.

Lieut.-Col. Lake.	By	Lieut.-Col. Bloomfield.
„ Flude.	„	„ Wilford.
Capt. H. Strange.	„	Capt. Baddeley.
„ S. E. Gordon.	„	„ Bayly.
Lieut. H. P. Yates.	„	Lieut. Cockburn.

Lieut.-Col. Wilford having, to the regret of the Committee, announced his wish to retire from it, the Meeting has now to choose two Colonels or Field Officers, and two other Officers.

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The following Resolutions were then put, and carried unanimously:—

1. *Resolved*, that the increased rate of Subscription proposed at the Meeting, on the 10th October, 1853, be adopted, the votes in favour of the measure already exceeding two thirds of the whole number, namely:

Assents, . . . 458 | Dissents, . . . 17

2. *Resolved*, that it is expedient to re-impose the Entrance Subscriptions, which were abolished at the same Meeting, as far as relates to all Officers who may join the Institution hereafter.

3. *Resolved*, that the best thanks of the Meeting are given to the Donors of the various presents announced this day: to Colonel Sabine, Mr. Abel, Lieut.-Col. Adair, Lieut.-Col. Portlock, R. E., and the other Officers, who have delivered Lectures at the Institution since its opening, and to Capt. Webb, R. E., for the valuable instruments he has deposited at the Observatory.

4. *Resolved*, that the appointment of Lieut.-Col. Bloomfield, Lieut.-Col. Wilford, Capt. Baddeley, Capt. Bayly, and Lieut. Cockburn, to the Committee, is confirmed.

5. *Resolved*, that the following Officers be appointed to the Committee:—

Colonel Hardinge,	*vice*	Lieut.-Col. J. A. Wilson.
Lieut.-Col. Eardley-Wilmot,	„	Lieut.-Col. Wilford.
Lieut. Griffin,	„	Capt. Fraser.
Lieut. Milman,	„	Capt. Warlow.

Thanks were then voted to Lieut.-Col. Bloomfield the Chairman, and to the Secretary, and the meeting was adjourned.

(Signed) J. BLOOMFIELD, Lieut.-Col., R.H.A.

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DONATIONS.

LIST OF PRESENTS RECEIVED SINCE THE LAST MEETING.

Donors are requested to communicate any corrections to the following List:—

Curious old line Engraving "Johannes Hertzog Von Marleborow Generalissimus der Engl. Trouppen," with Prince Eugene, and the Margrave of Baden. *His Grace the Duke of Marlborough.*

Another Engraved Portrait of Johannes Herzog Von Marleborow Marggr Von Blanfort. *The Same.*

Charles, 3rd Duke of Richmond, Master General of the Ordnance 1782. *His Grace the Duke of Richmond.*

Charles, Marquis Cornwallis, Master General of the Ordnance 1795. *Lord Braybrooke.*

John, Marquis of Granby, Master General of the Ordnance 1769. *His Grace the Duke of Rutland.*

Dr. Olinthus Gregory, Professor of Mathematics, at the Royal Military Academy, 1802—1838, a bust. *Charles Hutton Gregory, Esq.*

Two Portaits of Dr. Olinthus Gregory. *Mrs. Gregory.*

Colonel Sir Augustus S. Frazer, K.C.B., Royal Artillery. *Lady Frazer.*

Lieut.-General Lord Bloomfield, G.C.B., G.C.H. *Lady Frazer.*

Major-General Sir Alexander Dickson, G.C.B., Royal Artillery. *Capt. Lefroy, R. A.*

View of the Town and Harbour of Grenada, West Indies, by Capt. H. A. Turner, R. A. *The Artist.*

View of the Harbour of St. George's, Grenada, West Indies. *The Same.*

View of St. Lucia, taken from Morne Fortuné, West Indies, by Lieut. Oldershaw, R. A. *The Artist.*

BOOKS.

Pamphlet, containing the Report of a Commission of French Officers, published in 1852—"On Pyroxyle, or Gun Cotton, and other Analogous Explosive Mixtures compared with Gun Powder."

[This Work has been presented by General Morin, one of the most distinguished Officers of the French Artillery, who visited the Royal Artillery Institution about two months ago, and gave a slight

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but very interesting sketch of the experiments on the above subject, to some of the Officers of the Regiment who were studying there.]

Preussisches Feld-Taschenbuch von F. Bushchbeck. Berlin, 1853. *Lieut.-Col. Bloomfield, R.H.A.*

Hand-Book of Chemistry, Abel and Bloxam, 1854. *Mr. Abel.*

Atlas des Principalles Battailles de la Republique. Paris, 1844. *Capt. Chermside.*

Nouvelle Atlas de la Geographie Universelle. Paris, 1845. *The Same.*

Recueil des Voyages au Nord. 10 vols. Amsterdam, 1731. *Lieut. Lyon.*

Turnbull's Voyage round the World. 3 vols. London, 1805. *The Same.*

Histoire Naturelle—Lacepide, in continuation of Buffon. 5 vols. Paris, 1819. *The Same.*

Paper on the Geology of the Bahamas, by Capt. R. Nelson, R.E. *The Author.*

Lectures on Animal Magnetism, by W. Gregory, M.D. London, 1851. *Lieut Breden.*

Researches in Magnetism, &c., &c.—by Baron Von Reichenbach, translated by Dr. Gregory. London, 1850. *The Same.*

Synopsis of the Natural History of Great Britain and Ireland, by J. Berkenhout. 2 vols. London, 1795. *Rev. Mr. Wright, Chaplain, R. A.*

Elements of Practical Astronomy, by J. R. Christie, Esq., F.R.S. London, 1853. *The Author.*

An Appendix to the Elements of Euclid, in 7 books, with fortytwo moveable schemes or diagrams, for forming the various kinds of solids, 2nd Edition, by J. L. Cowley, Professor of Mathematics, Royal Military Academy, 1770. *Capt. Lefroy.*

Traité de Balistique appliqué à l'artillerie navale—par Roche. 1re parte. Paris, 1841. *Capt. Richards.*

Le Manœuvrier, par Bourdé de Villehuet. Paris, 1814. *The Same.*

Elemens de Pyrotechnie. *The Same.*

Indagaciones Sobre la Amonedacion en N. Espana, *The Same.*

Paléontologie Francaise d'Orbigny. *Lovell Reeve, Esq.*

Course of Mathematics, for Royal Military Academy. 3 vols. *Lieut.-Col Portlock, R.E.*

Boxer's Treatise on Artillery. 1 vol. Diagrams, 2 parts. *Id.*

Jeffery's West India Atlas. *Lieut.-Col. Beresford.*

Hardinge's { Principles and Practice of Art—Elementary Art—Lessons on Trees—Lessons on Art. 4 vols. *Lieut. P. H. Yates.*

Measurement of an Arc of the Meridan. *Lieut.-Col. F. Eardley-Wilmot.*

Report of the Commissioners of the Great Exhibition. *The Same.*

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Morris' Catalogue of British Fossils. *Professor Tennant.*
M. Arago on the Comet of 1832. Trans. by Col. Gold, R. A. *Capt. Lefroy.*

MINERALS.

Heulandite White.
Heulandite Scarlet Red.
Axinite, magnificent specimen.
Harmatome.
Phillipsite.
Idocrase, splendid specimen.
Colophonite.
Series of six Fluors, all unusually fine.
Quartz Crystals, coated with oxydulous iron.
Detached Crystals of oxydulous iron.
Striped Jasper.
Pearlspar.
Tourmaline, very fine.
Chabasite.
Analcime.
Hyalite.
Chalcedony.
Mixed Copper and Iron Pyrites.
Red Oxide of Copper.
Tabular Crystals of Red Copper.
Sulphuret of Molybdena, very fine specimen.
Black Oxyd of Manganese.
Titanite or Rutile.
Thompsonite.

Capt. Richards.

A complete series of specimens, illustrative of the manufacture of iron, including the associated Geological formation; the ore; flux; coal and coke employed in smelting; 8 masses and 25 specimens of manufactured iron of different qualities, to exhibit fracture or grain; and the massive and vitreous scoriæ remaining. *The Directors of the Dowling Iron Works, through Major Aitcheson, late R. A.*

A series of 550 specimens, illustrating the Mineralogy of Nova-Scotia and New Brunswick. *Lieut. Griffin.*

A small collection of Cornish Minerals. *The Same.*

Various specimens to fill blanks in the collection. *The Same.*

Specimens of Specular Iron, with Quartz—Hematite: Sulphate of Baryta: Sulphate of Iron. *Lieut. Hope.*

A series of specimens from South Wales, chiefly Ores, illustrating the manufacture of iron. *Capt. M. Dixon. Lieut. W. Stirling. Lieut. C. L'Estrange. Lieut. Biddulph.*

Numerous Fossils, chiefly from the chalk, and the London clay, with a few good Minerals, to supply blanks in the collection. *Lieut. Cockburn.*

Specimens of Arragonite, Leucite, Bronzite, Oxide of Chrome, Titanite, Lapis-Lazuli, Riband Jasper. *The Same.*

Ammonite, of 17 inches in diameter, from the Chalk, Beechey Head—and other Chalk Fossils. *Capt. Dunlop.*

Various specimens in aid of the collection. *Professor Tennant.*

Specimen of the Metal Selenium, in the form of a Medallion of the celebrated Chemist Berzelius. *Mr. Abel.*

About 80 specimens of Ores and Minerals, principally American. *Lieut. Alderson.*

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Three specimens of the Fossil Wood, found near Cairo, Egypt. *Mr. Robert Pritchett.*

Four large specimens of Silicified Wood, from the Island of Antigua, polished. *Capt. J. D. Shakespear.*

A few Fossils from the neighbourhood of Landguard Fort. *Capt. Graydon.*

Fossil Remains from the neighbourhood of Woolwich. *Dr. Bossey.*

Five specimens of Minerals from County Clare, Ireland. Galena, Argentiferous Lead. Quartz, &c. *Lieut. Vandeleur.*

Scoriæ, from Souffriere Volcano, St. Vincent's, West Indies. *Capt. Chermside.*

Bitumen, from the Greenstone Quarry, Binnycraig, Linlithgowshire. *Capt. James, R. E.*

Candle made from Bitumen. *The Same.*

Holoptychius Hiberti, from Gilmerton, Edinburghshire. *The Same.*

Icthyodurulite, from Gilmerton, Edinburghshire. *The Same.*

NATURAL HISTORY.

Eighty-three specimens of Birds; twelve specimens of Quadrupeds. *Director-General of the Medical Department, Royal Navy.*

Thirty six specimens of Bird's Skins, chiefly from Norway. *Capt. Biddulph.*

Specimens of Birds, chiefly British, in glass cases. *Mr. Delafield, through Capt. Phelips.*

Specimens of Corals from Bermuda. *Miss Gregory.*

Specimens of the Coral, called Barbadoes Fan. *Capt. H. Turner.*

Ditto. *Lieut. Griffin.*

A collection of sea shells. *Colonel Gordon.*

Ditto, a large collection from the Pacific. *Capt. Strange.*

Ditto. *Mr. Whiteley.*

Ditto. from Bermuda. *Capt. Shakespeare.*

Ditto. *Lieut. Cockburn.*

A collection of British Birds, Butterflies, and Insects. *Dr. Fisher, O.M.D.*

A fine specimen of an Alligator, shot by himself at Honduras, Feb. 1852. *Capt. Soady.*

Elephant's Foot—Skin of an Iguana, Cape of Good Hope. *Lieut.-Col. C. Burnaby.*

An African Armadillo; and Elephant's Ear. *Major Faddy.*

Trunk Fish, from Bermuda, (Cow Fish.) *Capt. Montresor.*

Two Crabs, from the West Indies. *Lieut.-Col. Flude.*

Two Lizards, from the Great Lake, South Africa. *Assistant Surgeon Fasson, M.D., by Assistant Surgeon Park.*

A Nest of Tarantula Spider, from the West Indies. The valve remarkably perfect. *Assistant Surgeon Park.*

A collection of 65 Bird's Skins, chiefly tropical—King Parrot, &c. *Lieut. Griffin.*

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Four Humming Bird Nests—Nest of Tarantula—Tail of Electric Ray, &c. *Lieut. Vandeleur.*
Seven Stuffed Birds in Cases. *Lieut. Hardy.*
Three Birds in Case. *Lieut. Dames.*
Specimens of the Pearl Mussel, from China. *Capt. P. Maclean.*
Cyclopterus Lumpus, (the lump sucker.) *Capt. James, R.E.*
Brama Raii, (Rays Bream.) *The Same.*

MISCELLANEOUS.

A Cossack Riding Whip. *Col. Anderson.*
An Indian Bow and 5 Arrows, from Honduras—4 ornamented Calabashes—A collection of Seeds. *Capt. Chermside.*
A complete Lapland Dress, and a pair of the narrow Snow Skates (*Skie,*) from the same region. *Lieut. Hill.*
A Carved Bowl, from New Zealand—two Stone Adzes—a Stone Ornament, in Jade. *Capt. Anderson.*
A number of Copper Coins, ancient and modern. *Lieut.-Col. Beresford.*
Two Flint Spear-Heads, found in a cromlech, in the Island of Alderney—a pair of Algonquin Snow Shoes, and Horns of Canadian Red Deer. *Lieut. Griffin.*
An Anatomical preparation of a Horse's Foot. *Capt. Brandling.*
Two Chinese Fans. *Lieut. Dames.*
Two Crocodile's Eggs, from the West Coast of Africa. *Lieut.-Col. F. Eardley-Wilmot.*
A Calabash, from the West Indies. *Lieut. Vandeleur.*
Ten Copper, and 1 Silver Canadian Coins—1 Turkish Gold Coin. *Lieut. Alderson.*
Specimens of Gutta Percha, in different stages of manufacture from the Eastern Archipelago. *Lieut. Parkin.*
Mass of Metal, from the U. S. Man of War Missouri, burnt at Gibraltar, 1841. *Capt. Cannon.*
Egyptian Figures. *Capt. P. Maclean.*
Three Silver Coins. *Lieut. Downes.*
Chemical Retorts, &c. *Dr. Stewart.*
Figures of French Artillery, in Cardboard. *Executors of Col. Colquhoun.*
Small Mexican Idols. *The Same.*
Four specimens of Indian Rubber, from South America. *The Same.*
Chinese Pith Hat. *Capt. E. Price.*
Indian Pouch and Brow Band.
Small Antique Vase, and Lamp, from Corfu. *Lieut. Elgee, 47th Regiment, by Capt. Elgee, R. A.*
A Pair of African Deer's Horns, (Gemsbok.) *Lt.-Col. Walpole, R.E.*
A Spanish Dollar, to illustrate the skill of the Chinese in debasing coin. *Col. Eyre.*

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PURCHASED.

BOOKS.

GOULD'S BIRDS of Europe. 5 vols. From a donation of General Whinyates, placed at the disposal of the Committee.
Elementary Instructions in Drawing. 3 vols.
Journal of the Palœontographical Society. 8 vols.
Johnston's Physical Atlas.
Yarrell's British Fishes. 2 vols.
Broderip's Zoology; Bellamy's Natural History.
Chapman's Elements of the Art of Drawing.
Hewitson's Eggs of British Birds. 2 vols.
Hawkin's Memoir of Ichthyosauri.
Von Buch, on the Canary Islands.
Dana's Mineralogy.
Watson, on Electrical Illumination.
Dove's Isothermal Charts.
A series of Portraits in aid of the collection referred to at p. 154.

INSTRUMENTS.

Four Prismatic Compasses, by Troughton.
A large Varlo's Stand, for the five-feet Telescope lent by Capt. Webb, R. E.

APPENDIX.

Charlemont, Ireland, 21st January, 1854.

DEAR LEFROY,

My Brother has forwarded your letter respecting the papers left me by my late Father. There are many obstacles to the publication of them on my part, and not wishing the information to be entirely lost, I handed them over to Jervis, (on application) who informed me of his intention of forming a History of the Regiment; he received them with a proviso, that my Father's name should be mentioned in the work. When he has obtained all the information he requires, I should have much pleasure in presenting them to the Institution to aid in the purpose you mentioned. Perhaps you would be kind enough to communicate with Jervis on the subject, that my wishes may be carried into effect.

Believe me yours, truly,

SAMUEL CLEAVELAND.

In a subsequent note, dated 31st January, 1854, Capt. S. Cleaveland adds:—In reference to an opinion expressed by Capt. Lefroy, that the work might possibly yield some pecuniary profit on being published. "I wish it to be clearly understood, that the gift is a free one, such success as you refer to would afford me much pleasure, but I should most decidedly decline any participation in the advantage."

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Woolwich, January 24th, 1854.

My Dear Lefroy,

Having been for some time occupied with a history of the Artillery, I should much like to know what encouragement the Institution would give to such a work. It was not my intention to confine myself to the mere historical or tactical details, but I am desirous to indicate the effect which the discovery of gunpowder has had on society. To do this properly, requires that the great change which took place in Architecture during the Fifteenth Century, and the subsequent gradual introduction of modern fortifications, should be exemplified by drawings, as well as the different mechanical contrivances in use from time to time for the construction and moving of guns.

The means of making such collections are ample, I copied from manuscripts in Paris, drawings of the various engines and guns in use during the Fifteenth Century. Many of our own illuminated manuscripts in the British Museum, and the Italian families of Litta, afford specimens of the system of sieges in the Fourteenth, whilst the works of Francesco di Giorgio, of Marchi, of San Michele, abundantly illustrate the gradual change which introduced the bastion system, instead of the round tower and wall. A selection might, therefore, be made from the above, to illustrate the subject in question, and it is one of far more importance than is generally thought. The use of gunpowder caused numerous experiments to be made in the casting of bronzes, and in the working of iron, which was afterwards turned to account when manufacturing these metals for domestic purposes. The moving of these heavy engines induced people to construct roads, whilst the little resistance afforded by castles, or town walls, introduced the palaces of Italy, and did away with many of the inconveniences of the city regulations. * * * * *

In Paris I also copied all that Leonardo da Vinci's manuscripts contained respecting gunnery, and was not a little surprised at finding two points not generally known. First, that steam had been made so far an object of study in his age (about 1500) that it had been applied to a steam gun. Secondly, that not only had the theory of curves begun to be a subject for discussion, but that studying the nature of the flight of projectiles had led to the theory that the earth was not a stationary planet, some sixty years before Galileo.

I would therefore propose undertaking the history of Artillery from the earliest times up to the middle of the Eighteenth Century, treating it as a whole, without reference to country. At that period a new epoch commences, arising from the great discoveries made subsequently in chemistry, and the experiments of Robins, Hutton, &c., that, I think should be a separate affair, and the strictly Regimental history a third. But it is no good labouring without feeling some confidence that the labour will not be fruitless, and I should therefore like to know how far the Institution would be likely to go towards publishing such a work. Believe me, Yours Truly,

H. J. W. Jervis.

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Erratum in the preceeding Report, page 161.

INSTRUMENTS PURCHASED.

A large sized Camera for Photographic purposes, from the fund placed at the disposal of the Committee by Major-General Whinyates.

LIST OF THE COMMITTEE FOR 1854.

President.

THE MASTER-GENERAL.

Vice-Presidents.

THE DEPUTY ADJUTANT-GENERAL.

THE DIRECTOR-GENERAL OF ARTILLERY.

THE COMMANDANT.

Members.

THE ASSISTANT ADJUTANT-GENERAL.
THE ASSISTANT DIRECTOR-GENERAL.
THE BRIGADE MAJOR.
COLONEL HARDINGE, K.H.
COLONEL BLOOMFIELD, R.H.A.
LIEUT.-COL. TULLOH.
LIEUT.-COL. F. EARDLEY WILMOT.
CAPT. W. M. DIXON.
CAPT. BOXER.

CAPT. BADDELEY.
CAPT. N. S. BAYLY.
CAPT. J. W. JERVIS.
LIEUT. C. F. YOUNG.
LIEUT. G. A. MILMAN.
LIEUT. C. F. COCKBURN.
LIEUT. F. C. GRIFFIN.

DR. SAVAGE, O.M.D.

CAPT. J. H. LEFROY, *Secretary.*

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No. 23.—NOTES on the Establishments of the British Field Artillery since 1815, with the Report of the Committee of Revision of 1819, and other documents.

By. Capt. J. H. LEFROY, R. A.

The present paper consists of a series of documents not immediately connected with one another; but all having reference to the Equipments or Regulations of Artillery for Active Service.

The Report of the Committee of Revision, of 1819, from the importance long attached to it, may be properly given first; but some documents of an earlier date will be found in an appendix. The Committee in question was appointed by the Duke of Wellington, at that time Master-General of the Ordnance, upon a representation from General Sir A. Farrington.*

It consisted of the following Officers:—

General Sir A. Farrington, Bt.	Major-General Borthwick.
Lieut.-General Douglas.	*Colonel Millar.*
„ Ramsay.	„ *Sir W. Robe, K.C.B.*
„ Macleod.	*Lieut.-Col. Sir A. Frazer, K.C.B.*
„ Cuppage.	„ *Sir A. Dickson, K.C.B.*
„ Willington.	

Of whom those printed in *italics*, with the addition of *Colonel Sir G. Wood, K.C.B.*, formed the Sub-committee, by whom the report was prepared. The state of his health prevented Sir George Wood from taking any active part in the work. The Report of the Committee, dated 10th April, 1820, was received and considered, with his accustomed care, by the Duke of Wellington; whose penciled remarks are here inserted, together with the replies of the Sub-committee, and further remarks by a Member, (said to have been Sir W. Robe:) but it was never officially adopted. It has always been considered a document of great value—copies in manuscript are fre-

Woolwich, 1st December, 1819.

* MY LORD DUKE,

From the experience which has been gained in the Field and Siege Service of the Artillery during the late War, and more especially in the Campaigns under your Grace's orders, in the Peninsula, and France, the result of which, if collected and placed upon record, would prove of considerable advantage in facilitating future equipments, I beg leave to submit the subject to your Grace's consideration, and to request, should it meet your approbation, that I may be authorized to call together the Select Committee, to be assisted by such Officers of the Regiment, and the Heads of Departments, as the Committee may consider best capable of affording information of those operations in the late War; for the purpose of making a revision of the several equipments in the Artillery Service, and under each head, reporting such alterations as may be deemed advisable

I have, &c.,

A. FARRINGTON, General.

General Farrington, who died in 1823, was the last surviving Officer of the epoch of the Seven years War. His first Commission dated from 1755, and that War, in which the British Artillery, under Captain Phillips, rendered good service, was commenced in 1756.

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quently to be met with; and in 1828, it was printed, but without authority, in the British Indian Military Repository, published at Calcutta. Under these circumstances, the Committee of the Regimental Institution have sought and obtained the sanction of His Lordship the Master-General to a reprint of it; or of so much of it as subsequent alterations in the service, have not deprived of its value. The composition of Troops and Batteries contemplated by the Committee, for example, assumed the continuance of the Driver Corps.

The detail of a 9-Pr. Field Battery for Foreign Service, as proposed, was as follows:—

ROYAL ARTILLERY.	ROYAL ARTILLERY DRIVERS.
2 Captains.	1 Lieutenant.
3 Subalterns.	1 Staff Serjeant.
1 Medical Officer.	2 Serjeants.
3 Serjeants.	5 Corporals.
3 Corporals.	1 Trumpeter.
6 Bombardiers.	1 Farrier.
2 Drummers.	4 Shoeing Smiths.
90 Gunners.	1 Carriage Smith.
	2 Collar-makers.
	2 Wheelers.
	84 Drivers.
110	104—Total, 214

With 164 Horses and Mules, to 19 Carriages.

The abolition of the Driver Corps in 1822, since which period every Artillery Soldier has been enlisted as a Gunner and Driver, (G. O., Sept. 28th, 1821,) has rendered all the Tables based on this constitution useless, save a matter of curiosity. Where the Tables of Equipment also are identical with those at present authorized, or are to be met with in the ordinary works of reference, a statement of the fact is considered sufficient.

The reduction in the strength of the Artillery, commenced immediately upon the conclusion of the war in 1815, was completed in 1819. From the imposing amount of 23,085, at which it stood in the estimates of the former year, it had been cut down to 6,881 in those of the latter. The country was exhausted by the struggle then terminated. So great was the distress of the agricultural and manufacturing poor, that we find subscriptions for their relief entered into, even in the army then in France. In 1816, the Officers of the Artillery at Valenciennes and elsewhere, remitted £100 to this fund.

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The strength of Artillery maintained at that epoch, must be considered therefore as governed by the necessities of the state, not as a criterion of what the service, or the just proportions of an army, required. Even in 1826, when the Duke of Wellington, as we are told, wished to augment the strength of Companies from 59 to 80 Gunners and Drivers, he was under the necessity of contenting himself with a strength of 70 Gunners and Drivers,* at which they were embarked, with Batteries of 3 Guns and 1 Howitzer, for the expedition to Portugal in that year. Happily the cause just assigned for the reduction of the Artillery of the Imperial Army,† has ceased to depress it. Various mechanical and scientific improvements have given a new and tremendous power to this arm of the service; greatly altering the character, not only of naval armaments, but of all land defences since the war. Thus its importance has been more strongly felt, and the example of all military powers, as well as the increasing magnitude of the interests staked on the efficiency of the Army of Great Britain, have led the Government to carry out successive augmentations, which have raised the strength of the Regiment, from the minimum scale of 6,365 men, of all ranks, which it attained in 1823 and 1824, and from which it did not very materially differ until 1846, to the present establishment.‡

These details belong perhaps properly, to a History of the Regiment; but questions of equipment to which the report below chiefly refers, cannot be entirely separated from those which involve the *personel* of the force to apply it. We owe more particularly to these augmentations the re-appearance, after a lapse of more than thirty years, of a Field Artillery, of great efficiency and power; inheriting the legacy of a brilliant reputation from the last great war in which it was engaged, and qualified by every requisite, save perhaps experience, to sustain it in the present one. The following brief notes of the changes which this branch of the service has undergone since the period of its former activity, and which are chiefly compiled from documents I have been permitted to consult in the Deputy-Adjutant General's Office, will be useful as an introduction to the subject of equipments.

* Sir H. Hardinge before the Committee of Finance 1828, p. 61.

† The powerful Artillery of the Armies of India must not be overlooked as a part of the Military Force of Great Britain.

‡ The estimates for 1854—5 provide for:—

	MEN.	HORSES.
Royal Artillery, 104 Companies,	15,013	1,608
Royal Horse Artillery, 7 Troops,	1,124	904
Riding Troop, 1 Troop,	35	25
	16,172	2,537

Since added to the Battalions 1,040 men, distributed at 10 per Company: and 5 Gunners per Troop: a special addition of 1 Shoeing-Smith, 12 Gunners, and 14 Drivers, has been made to one Troop, to qualify it for a battery of 9-Pr. Guns. The additional horses purchased, or to be purchased, amount to 1,500. *September*, 1854.

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From 1805 to 1817, the Horse Artillery consisted of 12 Troops, each of 5 Officers, 14 or 15 N.C. Officers, 60 Drivers, and 80 or 90 Gunners, with 164 Horses. This establishment being inadequate to all the requirements of active service; it was customary in the field to attach a few of the Driver Corps, with additional horses or mules to each Troop. The strength of the Detachment of the Driver Corps so attached, was fixed, in August, 1811, at 1 Corporal, 3 Artificers, and 20 men, with 36 Mules for each of the four Troops then in Portugal. The Mules were thus distributed:—

Forge Waggon, ...	6
2 Store Waggon, ...	12
1 Curricle or Store Cart, . .	4
N.C. Officers', ...	2
Baggage and Spare, . . .	12
	36

This constitution lasted down to the campaign of Waterloo. The Troops of Horse Artillery, which embarked at Ramsgate for Belgium in April, May, and June, 1815, consisted mostly of:—

Officers, ...	5
N.C. Officers, ...	14
Gunners, ...	82
Drivers, ...	60
Artificers, ...	7
Trumpeter, ...	1
Total,	169
Horses, ...	164

And by the subsequent monthly returns, we find a N.C. Officer, and about 20 of the Driver Corps added to each, with an average total of 208 Horses or Mules—the troops are not all of precisely the same force.

A Battery of Horse Artillery at this time, consisted of:—

2 9-Prs. or 2 Heavy 6-Prs.	1 Spare Wheel Carriage.
1 Heavy 5½-inch Howitzer.	1 Forge Waggon.
3 Light 6-Prs.	1 Store Waggon.
6 Ammunition Waggons.	1 Small Cart.
3 Reserve Waggons.	19 Carriages.

The Armament was changed before the battle of Waterloo, as is well known. Three of the Troops received five 9-Prs., and one 5½-inch Howitzer; four of them received five Light 6-Prs., and one

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5½-inch Howitzer; and the other received six 5½-inch Howitzers—but these changes it is not our object at present to consider.*

In July 1816, the Troops of Horse Artillery were reduced to a Peace Establishment of 5 Officers, 11 N.C. Officers, 56 Gunners, and 24 Drivers; with the exception of those serving in France, which retained 14 N.C. Officers, 85 Gunners, and 56 Drivers. There were also the following Artificers attached to each Troop:—

	Full Establishment.	*Reduced.*
Farrier and Smith,	1	1
Carriage and Shoeing-Smith,	1	1
Shoeing-Smith,	2	1
Collar-makers,	2	1
Wheeler,	1	1
	7	5

Five Troops, one of them a Rocket Troop, were reduced in 1817: and in May 1819, the remaining seven Troops were placed upon the skeleton establishment of 5 Officers, 10 N.C. Officers, 46 Gunners, 18 Drivers, 5 Artificers, 1 Trumpeter. Total 85, with 36 Hores for two Guns; which they continued until 1828. In this year two Troops serving in Ireland were augmented to four Guns, which addition was extended to the remaining five Troops in 1848. The number of Horses to a Troop was then fixed at 63 for England, and 70 for Ireland—and so continued until 1852, when the Troops were all raised to six Guns, as at present.†

Adverting next to what are now called the Field Batteries.

From 1808 to 1816, a Company of Artillery consisted of 5 Officers, 17 N.C. Officers, and 120 Gunners, with 3 Drummers. Total effective 145. When attached to a Field Battery, then called a Brigade of Artillery, a proportion of the Driver Corps, under a Subaltern of that body, was attached to the Company, together with the requisite number of Horses. The strength of this addition for a 9-Pr. Brigade, with two reserve ammunition waggons, was fixed by Lieut.-Col. Framingham, commanding the Royal Artillery in Portugal, August 5, 1811, and approved by Lord Wellington, as follows:—

Lieutenant,	1
Serjeants,	3
Corporals,	6
Trumpeter,	1

* 9-Pr. Troops. A. Lieut.-Col. Sir H. D. Ross: G. Lieut.-Col. Sir A. Dickson, actually commanded by Captain A. Mercer: H. Major N. Ramsay.
6-Pr. Troops. E. Lieut.-Col. Sir R. Gardiner: F. Lieut.-Col. Webber Smith: D. Major Beane: Rocket Troop, Captain E. C Whinyates.
The Howitzer Troop. I., Major Bull.

† The present establishment of a 6-Pr. Troop for Home Service is 5 Officers, 15 N.C. Officers, 85 Gunners, 50 Drivers, 6 Artificers, 1 Trumpeter. Total 162, with 136 Horses. And for Foreign Service 5 Officers, 15 N.C. Officers, 85 Gunners, 77 Drivers, 9 Artificers, 1 Trumpeter. Total 192, with 202 Horses. The Medical Officer is not included in either case.

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Farrier,	1
Shoeing-Smiths,	4
Jobbing Smith,	1
Collar-makers,	2
Wheelers,	2
Drivers,	96
Total,	117
Riding Horses,	18
Draught Horses,	142
Baggage Mules,	10
Total,	170

And the Battery consisted of:—

6 Guns,	each	8	Total	48	Horses.
6 Ammunition Waggons,	„	6	„	36	„
2 Reserve Waggons,	„	6	„	12	„
2 Store Waggons,	„	6	„	12	„
1 Wheel and Spare Carriage,		8	„	8	„
1 Forge,		6	„	6	„
1 Small Cart,		2	„	2	„
19					

The Brigades sent to Belgium in 1815, differed from the above, chiefly in the substitution of two Forage Waggons for one Store Waggon; making 20 instead of 19 Carriages in all, with 163 Horses and Mules.

The Drivers of these Brigades were paid, mustered, and subsisted separately from the Company, as a detachment from one of the large Troops into which that Corps was divided, and which at one time mustered 614 each, of all ranks. The Captains commanding the Brigades had but an imperfect power of control over many interior details of their management—on the other hand, the Driver Officer, beyond the stable and civil duties, had little authority, none at all over the Gunners of the Company; and was the junior in rank of all Officers of Artillery. Much inconvenience arose from this arrangement, which was partly attributable to the slender tie subsisting between the Driver Officers and their men, and to the inferior position of the former As a partial remedy, which, however, is stated to have been attended with considerable success, the Officers belonging to the Troops of Horse Artillery, reduced in 1817, were transferred to four reduced Troops of Drivers, which thus became a special Corps, Officered by the Royal Artillery. The remaining eight Troops of Drivers were entirely reduced; and this force, which while it

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lasted, is a measure of the dismounted Field Artillery of England, or of what we now call the Field Batteries, in contra-distinction from the Horse Artillery; was reduced from twelve Troops, numbering altogether 7,390 of all ranks, at which it stood in 1814; to four Troops, numbering 1,461 of all ranks, at which it stood in 1817.

In March 1817, the Companies of Foot Artillery were reduced to a strength of 5 Officers, 9 N.C. Officers, and 59 Gunners: those serving in France excepted, which retained 70 Gunners, and the Drivers shewn below. The Field Artillery, attached to the army of occupation at this period, comprised nearly the entire portion of the Regiment maintained on that footing. There were but four skeleton Brigades in Great Britain, exclusive of four reduced Troops of the Horse Artillery; each of two 6-Pr. Guns, with 15 of the Driver Corps, and 20 Horses: they were stationed at Portsmouth, Plymouth, Weedon, and Leith. There was also in 1818, a Brigade of 4 Guns, 35 Drivers, with 46 Horses, at Paddington; but it was reduced the following year. The distribution with the army was as follows:—

	Driver Corps.		*Horses.*
Attached to Major Unett's Brigade,	87	D Troop.	96
„ Capt. Gordon's Brigade,	87	D „	98
„ Major Roger's Brigade,	80	D „	100
„ Major Holcroft's Brigade,	87	D „	95
„ First Division Ball Cartridge,	52	D „	70
„ Major Carmichael's Brigade,	91	C „	100
„ Capt. Hutchesson's Brigade,	89	C „	98
„ Capt. Hunt's Brigade,	91	C „	97
„ 2nd Division Ball Cartridge,	55	C „	74
„ 3rd Division Ball Cartridge,	55	A „	67
„ Reserve Valenciennes, under Major Whinyates,	76		37
„ Head-Quarters Valenciennes, Captain and Adjutant C. Blachley,	50		18

Total, Captain,	1	R. A. Drivers,	706
„ 2nd. Captains,	2	Rough Rider,	1
„ 1st Lieutenants,	8	Trumpeters,	11
„ Adjutant,	1	Farriers,	11
„ Quarter-Master,	1	Shoeing-Smiths,	28
„ Veterinary Surgeon	3	Carriage-Smiths,	5
„ Serjeant-Major,	1	Collar-makers,	18
„ Staff Serjeants,	11	Wheelers,	17
„ Serjeants,	23		
„ 1st Corporals,	22	Total,	900
„ 2nd Corporals, afterwards Bombardiers,	30	Horses,	956

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To this number must be added 4 Officers, 27 N.C. Officers, 2 Trumpeters, 18 Artificers, 292 Drivers: total, 343, serving with the Pontoon Train.

The return of the army of occupation from France, which took place in November 1818, was followed by very extensive reductions. In the estimates for the year 1821, we find only three Troops of the Driver Corps of 100 Drivers in each, with 46 Horses for mounted Officers, 50 for mounted N.C. Officers, and 300 for draught. To which may be added, 4 Officers, and 15 Troop Horses on the Riding House-Establishment: 30 Riding Horses, and 117 Draught Horses were maintained in Ireland, and the expense provided for on the Irish estimates; but they are included in the total numbers above. In this year was effected the change which absorbed the last remains of the Drivers into the Royal Artillery, and provided that, henceforward, no permanent distinction should exist between those parts of the Corps which may be appointed to Field and Garrison duties.

The General Order, dated 21st September, 1821, directs the reduction of 5 men from each Company of the Foot Artillery, amounting to 360 men in all; and the transfer of 4 men from the Driver Corps, with 5 Horses to each Company; or 32 Drivers, and 40 Horses to each Battalion. "From this time forward," it adds:—

"Every man enlisted for the Royal Artillery, is to be enlisted as a Gunner and Driver, and is to be liable to be employed either as Gunner or Driver, as his services may be required.

"The Commanding Officer of the several Battalions will decide to what service the several men are to be trained, but it will be expected that one half of the establishment of each Company, shall be trained to the care and management of Horses, as well as to the service of the Artillery.

"One of the Drummers of each Company of Artillery is to be trained as a Trumpeter. Besides this, one man of each Company is to be trained as a Shoeing and Carriage-Smith, and one as a Collar-maker.

"The mode in which the duty must now be carried on is as follows:—The Drivers belonging to the whole Regiment must remain at the Head-Quarters of the several Battalions, at Woolwich, excepting those belonging to the Companies detached in Ireland, till a sufficient number of the Drivers of the Companies stationed at Woolwich, and in Ireland, shall be trained to take charge of the Horses.

"The Drivers and Horses belonging to each Company and Battalion in the Regiment, must be under the charge of the Officers, and N.C. Officers of such Company or Battalion; and when detached on any duty, must be ordered by detail from Head-Quarters, in the same manner as any other detachment is made.

"In consequence of this Draft of the Driver Corps into the Companies of the Artillery, there are to be reduced five men from each Company, by the discharge of that number of men. A Company of Artillery will then consist as follows:—

1 Captain.	8 Corporals.
1 Second Captain.	3 Bombardiers.
2 First Lieutenants.	1 Drummer.
1 Second Lieutenant.	1 Trumpeter.
1 Company Serjeant.	59 Gunners and Drivers.
2 Serjeants.	
	75

Further details of the new arrangement were promulgated on the 28th December, 1821. The commandant was directed to cause the whole of the N.C. Officers, Drivers, and Horses, at Woolwich, to be divided and inserted in nine lists, (the number of the Battalions.)

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The Drivers and Horses transferred to each Battalion, according to such lists, were to be equally divided among the Companies of the Battalion at Head-quarters, and mustered by them. The Company stationed in the Northern District, was to muster the Drivers and Horses doing duty with it at the time, which were to be included in the monthly returns of the Battalion.

N.C. Officers of Drivers to become supernumerary on the Battalions to which they might be posted in their several ranks. No promotion of N.C. Officers to take place in any Battalion until the Companies should be reduced to the new establishment.

A Subaltern of each Battalion was appointed weekly, by Battalion roster, to superintend the Drivers and Horses, and for stable duties; each Battalion continuing to find a Subaltern weekly for Garrison duty, as before.

A Captain of each Battalion to inspect, and make a weekly Report to his Commanding Officer.

One Farrier and Carriage-Smith,	One Collar-maker, and
One Shoeing and Carriage-Smith,	One Wheeler,

had been by the former order attached to the Staff of each Battalion. The Officers of the four Troops were *seconded*. So far as I have been able to gather from the recollections of others, the provision thus made for the instruction of all parts of the Regiment, even at its then strength, in that important section of the duties of Field Artillery, which is comprised in the care and management of Horses, and the art of Driving, was found to be inadequate; and when four years later, (in December, 1825,) an emergency occurred, which called for the equipment of three Field Batteries for Foreign Service, reason was seen for introducing a further modification of the system, which was carried into effect on the succession of Sir Alex. Dickson to the office of Deputy-Adjutant General, by a General Order, dated 25th April, 1827, as follows:—

GENERAL ORDER.

In order to place the Driver and the Horse Establishment, at Woolwich, in a more condensed and manageable form, to facilitate the instruction of Officers and Men in Field Artillery duties, and to expedite the formation of an adequate number of Drivers for Home and Foreign Service. His Grace the Master-General has thought proper to order, that there shall be formed three Field Batteries, and that the remainder of the horses shall be assembled as a reserve, and attached to one Battalion, with a due proportion of Officers and Men, for the purpose of instruction in the care of Horses and Driving.

The Companies attached to Field Batteries, are to remain posted to them for a period not exceeding one year: and the Officers and Men attached to the Reserve to be changed when found expert in Horse and Driving duties.

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Lieut.-Colonel Drummond is to be charged with the superintendence of this service.

The detail for the formation of the Field Batteries and the Reserve of instruction, will be issued hereafter.

J. E. JONES, Major,
Assistant Deputy-Adjutant-General.

Deputy Adjutant-General's Office,
Woolwich. 27th April, 1827.

GENERAL ORDER.

The following Companies are to be attached to three Field Batteries:—

Brevet-Major Douglas, 6th. Battalion.
Captain W. D. Jones, 3rd. „
Captain C. Gordon, 1st. „

Each Battery will consist of:—

4 Guns, ...	16	Horses.
4 Ammunition Waggons, .	16	„
Riding 3 Non-Commissioned Officers, 1 Trumpeter,	4	„
Riding for Officers, . .	4	„
Spare, ...	5	„
	45	
Two more the same,	90	
	135	

The remaining Horses will be mustered in the Ninth Battalion, and will form the reserve of instruction under Captain Bentham.

Lieut.-Colonel Drummond being charged with the superintendence of this service, will give the necessary orders, and all reports connected with it are to be made to him.

A. DICKSON, Colonel,
Deputy Adjutant-General.

The establishment of the system thus introduced, terminated the changes by which the Field Artillery of 1815, and that of 1854, are connected together. The number of Horses allowed to a Field Battery of instruction continued at 45 until 1852. We find, that in 1849, there were four-and-a-half such Batteries at Woolwich; and four demi-Batteries of service, having from 19 to 28 Horses each, in the north of England: there were also four Batteries of 4 Guns and 70 Horses each, in Ireland; two Guns at the Cape of Good Hope, and twelve, forming three Batteries of 60 Horses each, in Canada,

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these latter were established in 1838, one of them was reduced in 1853, and the others in 1854. In April 1852, the whole of the Batteries, whether of instruction or service, were placed upon an establishment of 6 Guns. The Reserve of instruction contemplated in the order, and which appears to have mustered 215 Horses when first formed, did not long continue to hold a distinct place in the system of instruction. The Companies attached in succession to the Field Batteries being in general entirely new to the duties required of them, those Batteries became Batteries of instruction, and nothing more; for the time seldom permitted a Company to attain more than a moderate degree of proficiency before it was replaced by another. (*Evidence before* the Select Committee on Army and Ordnance Expenditure, 818, *et seq.*) On the other hand, the Field Batteries being required to furnish, daily, a considerable proportion of their Horses for duties of fatigue and the public works: these duties, which were at first taken in turn by the Batteries, finally devolved entirely on the Reserve, to which Horses unfitted for more active duties were in general transferred. The Reserve ceased to be either actually or nominally an available part of the provision for the instruction of the regiment in the duties of Field Artillery, long before the next great step was taken in restoring that force to a serviceable condition.

In 1852, the government gave authority for the equipment of 120 Field Guns, to form twenty Batteries, on a reduced establishment. It was contemplated that three 12-Pr. Batteries, with 108 Horses each, should be retained in Woolwich; and ten 9-Pr. Batteries, on an establishment of 94 Horses each, be stationed in various parts of Great Britain and Ireland; to these being added seven Troops of Horse Artillery, on an establishment of 136 Horses each, we have the proposed number. The three 12-Pr. Batteries, at Woolwich, have been represented in general by four 6-Pr. or 9-Pr. Batteries, which are more convenient to handle, and extend the provision for instruction; but, as it is needless to remark, they could be converted at any moment to Batteries of 12-Prs.

These augmentations were dictated, not only by considerations of national policy, but also by the absolute necessity, under a system which requires every Artilleryman to be a Gunner and a Driver, of extending the means of acquiring and of keeping up the latter art; proportionably to the numbers to be instructed. Of the sagacity which enforced, and the wisdom which adopted them, it is certainly not necessary to speak at this moment, when we find that by their means alone, has England been enabled, with extraordinary rapidity, to send forth an army better provided with Artillery in proportion to its strength, than that of the Duke of Wellington was at any time of the Peninsula war: neither would it be judicious to enter now into any discussion of the advantages of the present system, when every thing has concurred to put it, for the first time, to an experimen-

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tal test. I cannot, however, better conclude this sketch, than by appending the opinions of Sir Alex. Dickson, after ten years imperfect trial of the system, as given before the Committee on Ordnance Expenditure in 1838:—

Major-General *Sir A. Dickson* examined, 17th July, 1838.

830. In the event of a war, would you think it necessary to return to the system of the Royal Artillery Drivers, which prevailed during the war, or do you think you could with confidence adhere to the present system laid down by the Duke of Wellington when he was Master-General?

As long as I am on the Staff, I pledge myself responsible to carry out the system that the Duke of Wellington laid down, as I fully believe it to be the most efficient.

831. From your knowledge of it in peace, and your experience of what is required of the Artillery in war, you think that that system can be applicable to a war similar to that carried on in the Peninsula?

I think it not only applicable, but that it would be a saving of some thousands of men in a service to the same extent as during the Peninsular period of the French war.

832. So that there would not only be a great saving of men, but there would also be greater economy and efficiency in the system?

I think so.

833. Is not it a system peculiarly applicable to the British service, considering its colonial service, its home service, and its liability to be called upon for foreign service at all times?

Those motives were the causes of its adoption, and they most cogently call for its continuance.

Lieut.-General Sir Hussey Vivian examined.

938. In 1814, it would appear that there were 88 Driver Officers, and 7,352 Drivers—do you conceive, that upon the present system, a much less number of Artillery Soldiers would replace those 7,352 Drivers?

I have no doubt of it. Sir Alexander Dickson is more competent to answer that question than I am, because he knows the details much better than I do: but I have no doubt in the field the Companies would not require to be so strong in men and officers as they were during the Peninsular war, under the old system of having Artillery Drivers, and Artillery Driver Officers.

Sir Alexander Dickson. I should think that 5,000 men would be equal to 7,000 Drivers.

939. And equally efficient?

And more efficient, the machinery would be much more perfect.

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EQUIPMENTS OF THE ROYAL ARTILLERY.

Report of the Sub-Committee, appointed for the Purpose of making a Revision of the several Equipments in the Artillery Service, and under each Head reporting such Alterations as they may deem advisable, as directed by the Select Committee, in their Minute of 15*th December,* 1819.

The Sub-Committee, in going through the investigation delegated to them by the Select Committee, have considered that the subjects of it may readily be classed under the following heads:—

1st. The arrangements and equipment of Field and Mountain Artillery.

2nd. Of Field Gun ammunition and stores.

3rd. Of Small Arm ammunition.

4th. The equipment of a Battering Train of heavy ordnance, including the requisite attending carriages, with the necessary ammunition and stores.

In entering on these subjects, the Sub-Committee have deemed it proper to annex detailed returns of the establishment of each equipment, adding such memoranda of explanation as appeared to be necessary.

Field Artillery.

1. The Sub-Committee, previous to their report on this subject, beg to recommend that the term Field Battery be adopted in the Artillery Service, as more definite than that of Brigade, for which, under this conviction, they have substituted it in the following report.

Composition of Field Battery.

2. The Sub-Committee has not deviated in the equipment of Field Batteries, from the existing organization by five Guns and one Howitzer, except in the case of the 18-Pr. Field Battery, which is proposed to consist of three Guns, and one 8-inch iron Howitzer, and in the cases of reserve Field Batteries, where Howitzers only may be used; which Batteries, when so constituted, will in like manner consist of six pieces, with the other appropriate carriages.

[*The Duke of Wellington.*] I believe the Batteries should consist of eight pieces, that is, of 6 Guns, and 2 Howitzers, and that a Company of Artillery is equal to this number of pieces. If this last position be true, or if a Company of Artillery is equal to the management of more than the Battery, it ought to consist of more, or in other words, of the number which a Company of Artillery of say 110 men can manage.

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[*The Committee.*] A Company of Artillery is certainly more than equal to the management of a Battery of six pieces, and could with ease manage a Battery of eight pieces. Indeed in the whole system of alloting a Company per Field Battery, it has always been understood that the surplus men should be applicable to the general service of the Artillery, such as reserves of gun ammunition, and musquet ball cartridges, escorts, depôt, &c., &c., on which accounts it has been considered unadvisable to calculate too nicely as to the number of men, especially in the first formation of a Corps of Artillery for an army; it will, however, be easy to apply a Company of Artillery of the present assumed strength to a Battery of eight pieces, if His Grace shall determine that Batteries shall be composed of that number.

[*A Member.*] This I heartily agree to, my own speculations on the formation of Field Batteries, having been for eight pieces, the manuscripts of which I have.

It forms a Battery, which, on first equipment, might be deemed sufficient to accompany a division on expeditionary service.

Rounds per Gun, and number of Cartridges.

3. The number of rounds per Gun required to sustain an action of some duration, has been assumed as a fair criterion to regulate the ammunition waggons to accompany a battery of each nature, independent of reserves.

This is shewn in Table No. 1, which contains:—

1st. The nature of Ordnance composing each Battery.

2nd. The number of rounds per Gun and Howitzer.

3rd. The ammunition waggons required to carry the quantity; and,

4th. The number and application of the carriages attendant upon the Battery.

Distribution of Ammunition.

4. In revising the distribution of ammunition in the limbers and waggons, and adhering strictly to the uniformity of packing, and to the power of substituting one limber, or one waggon, for another, the Sub-Committee, having considered the present proportion of case shot as too great, some diminution of it has taken place. This has permitted a small increase of the total number of rounds carried into the field. The case shot retained is proposed to be of one kind only, viz., for Guns of 41 balls in tiers, and for Howitzers of not less than 4 oz. balls.

It being considered that the spherical case is less efficient in the lower natures, and altogether useless with the 3-pr., the average proportion of spherical case to the total number of rounds, is proposed to be nearly as follows:—

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12-Prs., 1-3rd of total. 8-Inch Howitzers, 24 and 12-Prs., ½.
9-Prs., 1-5th.

[*W.*] I doubt this; I should say 1-6th.
[*C.*] The Committee have already very considerably reduced the proportion of spherical case with Field Guns, and fully concur in the further reduction proposed by His Grace.

Heavy 6-Prs., 1-7th.
Light 6-Prs., 1-8th.
Table No. 2 is explanatory of this.

Principles on which the Batteries are Horsed.

5. In forming the several general scales of equipment for Field Batteries, (vide Tables No. 4 to 17,) the Sub-Committee have been governed by one general principle in Horsing, viz., that for foreign service.

Every 18-Pr., and 8-inch Howitzer, requires 10 Horses.

Every 12, 9, and heavy 6-Pr., 24-Pr. Howitzer, and heavy 5½ Howitzer, 8 Horses.

Every light 6-Pr., heavy 3-Pr. Gun, light 5½ and 12-Pr. Howitzer, 6 Horses.

And all other Carriages belonging to a Field Battery, 6 Horses.

As these numbers exceed those of the establishment fixed in 1807,* though proved from subsequent experience to be required, the Sub-Committee think it necessary to state the grounds on which they have been adopted; observing at the same time, that equipments for home service are kept as low as possible, on the supposition of fixed stationary districts as heretofore, but with the acknowledged proviso, that in the event of actual warfare, they must be increased to the foreign scale.

Reasons for adopting these Principles..

6. It is not that in entering on a campaign six horses are absolutely necessary for drawing each carriage; nor that if travelling great roads with good stabling and forage, that such a number might be necessary at all. But when the whole of the animals are exposed to the weather day and night; traversing a country in all directions, whatever may be its nature, and with perhaps but a precarious supply of forage in quantity as well as quality, and having also occasionally after a hard day's march to seek the same for miles: in such cases, the powers of the animal, with every care, will be brought down in a short time to a much lower scale than under other circumstances might be reckoned upon.

If a difference of horses be proposed between the carriages which go into the first line in the field, and those for its immediate supply

* Appendix 1.

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or general utility; that is, between the gun and one waggon to each, and the remaining ammunition and other carriages; it is considered that a nominal and not a real saving would be made, from the over-work thrown on the latter carriages, causing, very shortly, greater expenditure of the horses than might otherwise be expected. For,

In alloting Horses to a Battery, the best are of course placed to the guns and ammunition waggons in first line, the next best to the spare ammunition, and the remainder to the forge and other carriages. The carriages in the first line must be at all times kept complete, and what cannot be supplied from the spare, must be from some of the rear carriages. The consequence is, that the rear carriages, and more especially those which do not convey ammunition, become weakened from the drafts in the course of the campaign, and unable to perform the duties required of them.

If it be urged that the rear carriages are not always close up with the operating part of the army, and by travelling great roads are not liable to so much fatigue, and therefore do not require so full an equipment: the answer is, that the ammunition carriages must always be at hand in the day of action, though in the rear; must consequently in great measure travel over the same ground, and must be capable of full exertion in conveying the ammunition when called for. They are otherwise of no use. The opportunity is lost. The gun is without ammunition, and may even be in danger after expending its stores, before a supply can be got up. That the other carriages are always at such times liable to an over-weight from a part of the forage on hand, from which the carriages in first line must be disencumbered; which forage would otherwise be lost, and the want of it reduce the condition of the horses. But the march of an army is not always made by great roads, but frequently by such as are marked out on the occasion by the Quarter-Master General's department across the country. Here the weaker carriages, by being in the rear, suffer most: what at first was perhaps but a bad road becomes a slough; and where the first carriages, well horsed, get through without much difficulty, becomes perhaps unpassable for those in the rear without the aid of each other's leaders, thereby causing delay, over-work of horses, and consequent expenditure of them.

Nor is the difference of equipment, in this latter view of the case, to any extent, being only 13 Horses for a 9-Pr. Battery, viz.:—

Forge, Store Waggons, and spare Carriages, .	6	Horses.
Three Ammunition Waggons, 2 each, . . .	6	„
Spare Horse, ...	1	„
	13	

The saving of which small number in first equipment would, it is considered, be likely to entail a much greater and constant demand

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for remounts, and be the cause ultimately of more detriment than advantage to the service.

These observations have not been made exclusively from experience gained in the late Peninsular campaigns, but also from those on the Continent, at the commencement of the late war. The Batteries then formed by the late Lieut.-General Sir William Congreve, with the present mode of carriage introduced by him, and also those constituted at Bremen, in 1795, being all arranged with six horse draft for rapid movement, in consequence of the experienced inadequacy of a smaller number in the improved operations of Field Artillery; and although the Artillery of the late army of occupation in France was on a reduced establishment, from motives of economy, yet the Sub-Committee, from past experience, are persuaded that an increase of equipment must have taken place, in the event of actual warfare.

The Sub-Committee have more dwelt upon this principle of Horsing the Carriages of Field Artillery, from its having met with the sanction of the late Master-General and Board, in consequence of the strong support it received from the Director-General of the Field Train, in his official transmission of a report called for by him in the commencement of the year 1813.

The Sub Committee are further desirous of preventing the recurrence of a necessity for any Officer, who may in future be placed in command of Artillery in continental campaigns, deviating materially from equipments established by authority; which some Officers have found themselves constrained to do, under great and to them very serious responsibility; or for their being reduced to the mortifying necessity of requiring aid from the infantry, ever reluctantly given, and not always attainable, for those powers of movement which every arm ought at all times to possess within itself.

Such are the reasons which have governed the Sub-Committee in forming the establishments of the several Batteries in point of Horses for draft, and have determined the appropriation of Non-Commissioned Officers, Drivers, and Artificers of the Train Division; so as to keep the number of riding Horses as low as possible, and to confine them to such persons only, as were absolutely necessary. The application of pack Horses for baggage has been made, in substitution for the two camp equipage waggons included in former equipments, and is taken from the practice in the Peninsula: the number of Horses or Mules being the same, it is considered more analogous to the movements of Field Batteries in all countries, the only addition being two Drivers.

[*W.*] This is a very serious question, and the Committee have exhausted the subject, at least on one side. In some seats of war, I am certain that the horses asked for are necessary, but it is equally obvious that they are more than are used for the same pieces of ordnance by any other nation in Europe. It is true,

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that our Guns and Carriages are heavier than others; but then our horse is a great deal better and more powerful, if taken care of. Upon the whole, I am for keeping the rule as it is, making the spare horses more numerous on foreign service, and really efficient, in order to provide for those circumstances which might occasion an exception.

[*C.*] This subject admits of discussion. The Committee are sensible that they have extra horsed, the whole of the ammunition carriages and other carriages of a Battery; they have done this with the view of rendering the Batteries efficient in the most extended meaning of the term; and they still consider themselves as preserving a line of real economy in earnestly desiring to retain the proposed number of Horses for the Guns, and one waggon for each, confirming the reduced numbers to the other carriages, and decreasing the spare horses from 1-10th to 1-15th or 1-20th.

They hope by their modification to meet His Grace's wishes, and on receiving His Grace's sanction for their adoption, can immediately proceed in drawing out the detailed scales of equipment.

[*M.*] I should very much regret to see a reduction of the spare Horses further than 1-12th. 1-10th has never been found too great a number, nor do I think it ever will be, except (as I believe is the case in the French service) moveable depôts of remount were established in the field, to which all sick Horses are sent, and the *chevaux haut le pied* were confined to a small number, actually carrying harness, and replaced as required. In Portugal and Spain, the proportion of spare was 1-8th; yet in the autumn of 1812, the proportion of sick horses to the whole in the country, was 1-7th, as appears by the return sent home. In other respects I agree with this reply.

Additional Note by the Editor.

The arguments here used by the Committee do not appear to have convinced the Duke of Wellington. The constitution of the three Field Batteries sent to Portugal in December, 1826, was upon the following very low scale:—

	Horses.	Total.
3 9-Pr. Guns,	6	18
1 24-Pr. Howitzer,	6	6
4 Ammunition Waggons, at	4	16
1 Forge,	4	4
1 Baggage Cart,	2	2
For Officers,	5	5
Non-Commissioned Officers,	5	5
Medical Officer,	1	1
Trumpeter,	1	1
Farrier,	1	1
Spare,	6	6
10		65
1 Reserve Gun Ammunition Waggon,	Unhorsed	
1 Reserve Howitzer Ammunition Waggon,	Unhorsed	
1 Spare Gun Carriage,	Unhorsed	
1 Store Waggon,	Unhorsed	
14 Carriages.		65 Horses.

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To which was allotted the following *personel*:—

	N.C. Officers and Men.	*Artificers.*	
To 4 Gun Detachments,	36	Collar-maker,	1
Mounted N.C. Officers,	5	Wheeler	1
Trumpeter and Drummer,	2	Farrier,	1
Officer's Servants,	5	Shoeing-Smith,	1
Drivers,	26		
Spare Drivers,	7		
Company of Artillery,	81		4

It is well known that Lieut.-Colonel Webber Smith, whose great ability and experience led to his selection for this command, felt himself unable to conduct the service upon such a scale of equipment; and almost immediately on landing proceeded, with the sanction of Lieut.-General Sir William Clinton, to enlarge it. Finding himself unable to purchase country Horses or Mules fit for draught, he withdrew the Horses from the Division of Ball Cartridge Ammunition Waggons, eight in number, which accompanied the army, and substituted country Horses or Mules for all the riders. The Ball Cartridge Division furnished 52 Horses fit for draught, the previous Riding Horses were 13 per Battery. With this additional strength, the number of Draught Horses was brought up to 82 per Battery, which allowed eight to each Gun or Howitzer, and six to the other Carriages. Sir William Clinton expressly directing him to move the Ammunition Waggons with six Horses each, and to leave two behind, in preference to having six with each Battery, with only four Horses each.

Lieut.-Colonel Webber Smith was re-called by the Duke of Wellington in consequence of this deviation from his orders. In his instructions to Lieut.-Colonel Sir John May, the Officer appointed to succeed him, (dated February 8, 1827,) the Duke of Wellington directed that he should immediately restore the equipment exactly to the state in which it was first established, it was added :—

"In fixing the number of Horses for the Guns at six, and for the Waggons at four. His Grace was guided by the consideration that Portugal could hardly be considered in a state of war: that the Horses of the Detachment were young and efficient, and that the country, not having been over-run with armies, as was the case during the last war, could supply the Forage required by Sir William Clinton's small Division, without difficulty or irregularity. Under these circumstances, and bearing in mind the little probability of any very active service for the Troops in Portugal, you will give the equipment, ordered by the Master-General, a fair trial, and report for His Grace's information. You will understand, however, that it is by no means the Duke's object to take any step which should risk the efficiency of the Artillery under your orders. He only desires that the fact should be accurately *ascertained*, whether the equipment which he has fixed upon, is, or is not, equal to the duties which may be required of it. In the event of your finding that the additional Horses are necessary, you will not hesitate to communicate your opinion to the Master-General, whom you will find disposed to pay every attention to your Report." [*MSS of the late Sir John May.*]

The Report of Sir John May, was confirmatory of the views of Lieut.-Colonel Webber Smith, whose dispositions were then sanctioned.

In reference to the former remark of the Duke of Wellington, that the scale of equipment proposed by the Committee was larger than that in use in any other army, see Appendix II.

N. C. Officers, Drivers, and Artificers.

7. The Non-Commissioned Officers, Drivers, and Artificers have been, as is already stated, kept as low in point of numbers, as the duties which each class has to perform would permit. With respect to Artificers, the Shoeing-Smiths have been taken at one to about forty Horses; the other Artificers generally at two of each per Battery, from the obvious inconvenience to any equipment on service, in the event of the only one being sick. Had the principle established by the Duke of Richmond, when Master-General of the Ordnance, that each Company of Artillery should have certain Artificers in its number of Gunners, been more acted upon, the aid of

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the second Artificer with any Field Battery might thence be obtained, and the necessity for two in the Train Division be avoided: as would also be the appropriation of civil Artificers accompanying any reserves; the inconveniences and great expense attending this class of men on a command entirely military, having at all times been severely felt.

[*W.*] How is this in the Cavalry?

I doubt this: Batteries are seldom quite alone and detached, and the strength of one can easily be applied to another.

[*C.*] The mode of shoeing in the Cavalry differs essentially from that followed with Artillery, which is very superior to it. The Cavalry Farriers retain on Foreign Service the home allowance of ½d. per day per Horse, finding the iron. The Cavalry are in consequence frequently ill shod. The allowance of one Shoeing-Smith to 40 Horses is known to be reasonable: a smaller allowance would lead to embarrassment in the event of sickness or casualty among the Shoeing-Smiths, which must occasionally be expected.

The two Artificers (Wheelers and Collar-makers) will probably not be considered too much, as the carriages and harness are increased.

If the suggestion of encouraging Artificers among the Gunners should be attended to, it is clear that little or no expense could accrue to the public, as the second workman would only receive a trifling additional allowance when employed in that capacity.

Artillery, one Company per Battery.

The number of Officers, Non-Commissioned Officers, and Gunners of Artillery, in the scale established in 1807,* being much too low for any Field Battery consisting of six pieces of Ordnance, and that scale having been formed on the supposition that one Company of Artillery, and one Division of Drivers, sufficed for two Batteries, leaving no source from whence sickness or casualties could be replaced, has from experience been found altogether inadequate. The Sub-Committee have therefore assumed the principle, that one Company of Artillery, consisting of 5 Officers, 1 Company Serjeant, and 2 other Serjeants, 3 Corporals, 6 Bombardiers, 2 Drummers, and 90 Gunners, is not more than adequate to the service of a 9-Pr. Battery, being that in most general present use. That as a 12-Pr. Battery will require a few more men to work the Guns, and as a Light 6-Pr. may be worked with a less proportion, they have adhered to the principle of a Company per Battery, generally leaving any allotment of a few men from the smaller to the larger nature of Battery as a matter of

* See Appendix I.

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interior arrangement, according to the nature of Ordnance which an Officer commanding Artillery in the field may have under his orders. Table No. 3 shows the distribution of the Company to the several duties required with any Field Battery. That of the Train Division will appear by the scales No. 4 to 9, without other reference.

[*W.*] I concur in the principle, that a Company of Artillery, of which, in my opinion, the Gunner Drivers ought to form an integral part, ought to be sufficient for a Battery, of which a 9-Pr. Battery, for instance, ought to consist of 8 pieces. Those of larger calibre might have fewer, those of smaller more.

There is one point in all this which has not been attended to, and that is expense.

We must take care that we do not make this branch of the service so expensive, as that no country, even this, can bear the expense of maintaining in the field an efficient establishment of it.

For that reason alone, I should wish the whole of this to be revised.

[*C.*] The Committee fully concur in the idea, that the Drivers should form an integral part of a Company on Field Service. The Batteries of light pieces, as 6-Prs., might also readily consist of 6 pieces of Ordnance only, and those of heavy pieces, as 18-Prs., of 4.

In this case, the totality of a Company not being required with a Battery of light pieces, the spare men would naturally be applied to the reserves of ammunition and other duties, which, though not, strictly speaking, duties with Field Batteries, are nevertheless essentially useful.

The Committee are fully sensible how necessary it is to attend to expense; and on receiving His Grace's directions upon what principle Field Batteries should be formed, pledge themselves to make such reduction in the whole scale of equipments, as will shew how desirous they are of every economy, which shall yet leave the Field Artillery in possession of that efficiency, without which, the good of the service would not in their opinion be consulted.

Why the Company and Train Division are separately organized.

8. It is considered, from the nature of the service to which Companies of Artillery in the British service are liable, and the consequent varieties of manner in which foreign field commands are subject to be called together, more especially on occasions requiring secrecy and dispatch, that a Company of Artillery, and the Division of Drivers, which, when called together, form one constituted body attached to a Field Battery, must in some measure be kept in distinct

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interior formation: more especially as they are both liable to separation on emergencies of service, as for sieges on the one hand, and on the other for reserves of ammunition for pontoons, &c.; and that therefore the equipment of a Field Battery will take a few more Non-Commissioned Officers and Soldiers than it might require, if formed into one body constantly acting together, as in the service of most of the continental powers of Europe, or in the Horse Artillery in our own, where the duties of each class are in a great measure reciprocal.

[*W.*] I have already stated my opinion of the formation of the Company of Artillery and Gunner Drivers. This would be applicable to all situations in the British service, as I can shew, whether of siege, island, or colonial service, musquet ammunition, train for sieges, or reserve.

[*C.*] The Committee pefectly agree with His Grace's view of this subject; and if His Grace shall permit them, will point out the mode in which it appears to them that His Grace's wishes may readily be carried into execution.

Staff Serjeant wanted, Company Serjeant applicable.

9. While mentioning Artillery on foreign service, the Sub-Committee beg to remark the want of a Staff Serjeant to act as Serjeant-Major to the Battery, and to point out the present Company Serjeant as highly eligible to these duties, from his character, and the addition which he receives to his pay. On this idea, a Horse has been included for the Serjeant-Major in the scale of equipment.

Drummers, suggestions relative to them.

10. It may possibly not appear requisite to have two Drummers with a Company, when joined in field duties with a Train Division which has a Trumpeter. But as one Trumpeter has been found inadequate to the duties of a Field Battery, and the drum as an instrument, is inapplicable to Artillery Service, since it can neither be carried about with, nor heard by a Field Battery in movement, it is suggested that drummers should be taught the use of the bugle, so as to make them of use in the field, and that they should not be sent on service under an age at which they can bear the fatigues of a campaign.*

As Artificers of several trades are indispensably necessary in the Artillery Service, in all situations, the Sub-Committee cannot but consider that it would be of a benefit to the service if the drummers could be taught those trades; which might easily be accomplished by degrees in His Majesty's arsenal.

* All Drummers are now designated Drummers and Trumpeters, and the drum is used only at Head-quarters, in military music.—*Ed.*

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Arms of Artillerymen.

11. The Sub-Committee beg to remark, that the sword with which the Artillerymen are now armed, is in itself a very inefficient weapon for any purpose; and as the men are now ordered to be taught the sword exercise, in which a better weapon is used, they would recommend the adoption of that description of sword instead of the present pattern.*

Arms for Drivers.

They also are decidedly of opinion, that some defensive weapon is necessary for the Artillery Drivers, whose situation in action is arduous, and often much exposed to attack. This has already been adopted by the other nations of Europe, and is highly desirable in the British service, whether considered in its moral or physical effect.

Horse Artillery.

12. In examining the war establishment of the Horse Artillery, the Sub-Committee has considered that the adoption, of late years, of heavier Ordnance than originally proposed, has induced a necessity for increasing the number of men per Gun, both mounted and dismounted.

Without determining the question of the propriety of mounting the whole of the Gunners, to which the Sub-Committee feel much disposed, instead of carrying any on the carriages as at present, they have taken the mounted detachments at two Non-Commissioned Officers and eight Gunners per Gun. The experience of the late war, in which this arm has been much and efficiently employed, has proved that the numbers, especially of Drivers, borne on the establishment by His Majesty's warrant, are not adequate to the performance of the duties required; detachments having been added from the other branches of the Artillery Service to the scale of equipment for each Troop. The want also of Non-Commissioned Officers of Drivers, who have hitherto been constantly borrowed from the Train, to the exclusion of Drivers of Horse Artillery, has been severely felt on service: with the view of remedying this evil, and of at once pro-

* The Sword worn in 1820 was the Spanish pattern Hanger: it continued to be worn by all Gunners and Drivers attached to Field Guns down to 1826. In the expedition to Portugal, the men received the curved Light Cavalry Sword, with a sling-belt, and its use was continued until 1843, when a peculiar sword, with a saw back, was tried for a short time. The musquet was given up by the Battalion Artillery in 1845, and the Victoria Carbine introduced in its place, as the arm of Artillerymen not attached to Guns. This Carbine had a common Infantry bayonet, but the men attached to Field Guns wore, instead of the bayonet, and in the same belt, a Sword proposed by Colonel Dundas, having a steel scabbard, and a brass handle. The Drivers wore it attached to the saddle. About the same time, the Light Cavalry Sword of the pattern of 1822, was given to the Horse Artillery. The Victoria Carbine was replaced by the Artillery Carbine of 1853, of the Enfield-Pritchett construction, to which is attached a sword bayonet; this is worn by the Gunners attached to Field Guns, but not by the Drivers, who, at present, carry no defensive weapon. Two men of each Gun detachment are supplied with Carbines in the field.—*Ed.*

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viding for the performance of duties equally necessary in the Horse Artillery Battery, as in any other Field Battery, and of holding out the proper encouragement to deserving Drivers now shut out from the hope of promotion in their Corps, a small proportion of this class of Non-Commissioned Officers has been inserted in the scales No. 14 to 17, proposed for the future equipment. It will be seen, by comparison of these scales with those of Field Batteries, that little other difference will exist between the two than what is consequent on the nature of mounted or dismounted, or of Foot and Horse Artillery.

In quitting this subject, the Sub-Committee cannot refrain from expressing their opinion, that His Majesty's service would be benefitted if the Drivers for the whole of the Artillery Service were formed on one establishment, were in all respects similarly clothed and equiped, and were all equally eligible, when deserving, to promotion.

Perhaps this principle might be carried further, so as to bring the establishment of Horses as well as Drivers under one general arrangement, the Horses to be afterwards selected as the several branches of the service may require.

[*W.*] See remark on expense.

[*C.*] The Committee have no wish to urge this point, although they consider, that reduction in other parts of the equipment may induce His Grace to think favourably of this suggestion, which is not hastily offered, nor without much reflection.

13. With respect to the equipment of smaller Ordnance for local circumstances, the Sub-Committee have put together scales for the Light 3-Prs. of 4 feet and coehorn Howitzer, on carriages of single draft, with carts for ammunition, and also the 1-Pr. Amuzette; these pieces being considered especially adapted to the West Indies, and other island services, where the limited movements they may have to make must be regulated by the draft of mules, or by the assistance of men. For these the Sub-Committee have merely given the outlines of a scale, leaving the means of movement to be regulated by circumstances.

For mountain service, the Sub-Committee have put together scales of the two modes in most frequent use of the 3-Prs. and coehorn Howitzer of that construction, viz.: the one by pack carriage altogether, and the other by draft, a shaft carried by a mule attaching to the trail of the gun carriage.

Of these two modes, preference is given to the latter, as being easier for the mules, more readily brought into, and taken out of action, and as conveying more ammunition with the same powers, and being able to move in almost any road on which the former is capable of being transported.

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Harness.

14. With regard to Harness, the Sub-Committee beg to observe, as an arrangement is going on in the Carriage Department for improving Harness, they do not deem it necessary to make any observation on the subject at present; beyond expressing their belief that the greatest advantage will be obtained by the simplification of Harness now in progress.

Mode of supplying Horse Shoes.

15. The Sub-Committee, in considering the improvement which has of late years taken place, both in the mode of supplying the very necessary article of Horse Shoes for the Artillery Service, and in the quality of the article itself; nevertheless beg strongly to recommend, that when horses are sent on foreign from home service, the month's consumption of shoes, or one set per horse, which the farriers at home are expected to have ready fitted to the horses, may be permitted to be received into store; or in other words, that while such shoes last, the farrier may continue to receive the half-penny per day per horse, which is allowed by government to farriers on home service. This or some similar arrangement would prevent the loss now incurred by farriers, and would ensure the horse being well shod at the beginning of a campaign, as every soldier would in that case carry with him one set of shoes ready fitted to his horse. These shoes, according to the existing arrangement, being the private property of the farriers, are returned to, and probably sold by him to disadvantage, at the very moment when they are likely to be of most use.

A rule to continue the farriers' allowance for one month after debarkation, would meet the spirit of this suggestion.*

Proportions of Stores for two and six months consumption for Field Batteries, No. 18, 19, *and* 20.

16. The Sub-Committee have drawn out the proportion of ammunition and stores, which, in their opinion, should accompany Field Guns and Howitzers of each nature; and have added a proportion of stores which they consider as equal to a months consumption for a Field Battery under ordinary circumstances, and as proposed to be carried in the store waggon attached to each Battery. And also another proportion supposed adequate to six months further supply, and to remain in depôt.

These proportions are classed in the order in which it appears to the Sub-Committee, that returns of Field Ordnance should in future

* A modification of this rule has been sanctioned, and acted upon in the late expedition. The Farriers has received the allowance of ½d. per day during the outward passage, as compensation for the shoes on the horses —*Ed.*

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be made out. This order, as will appear in a subsequent part of this report, is also adhered to in the detail of Ordnance and Stores for a Battering Train.

[*W.*] I may here observe, that I don't see why the quantity of ammunition carried with a Battery of light pieces should be greater than that carried with Ordnance of heavier calibre.

Take the 9-Pr., for instance, as the standard of Field Ordnance, and suppose 150 rounds a Gun sufficient for a battle, why should a 6-Pr. or 3-Pr. have more?

A 6-Pr. or 3-Pr. will require fewer carriages to carry that quantity; but that is so much the better.

[*C.*] Considering 150 rounds as the quantity wished to be carried per Gun with a Battery, the carriages attendant on a 6-Pr. or 3-Pr. Battery will readily be decreased. It is however observable, that light pieces are both fired somewhat faster, and are more frequently liable to be called into action than pieces of higher calibre; for light Guns are generally with advanced corps, and are frequently engaged in operations preparatory to battle, when there may not be time or opportunity to replace the ammunition: and further, one waggon per Gun affords the essential advantage of occasionally transporting the Gunners for rapid movements.

Field Artillery Equipment for a Corps d' Armee, No. 21, and A. B. and C. referred to therein.

17. With a view of further shewing the scale of Field Artillery equipment considered necessary by the Sub-Committee, they have assumed a distribution of Artillery sufficient to place on an establishment a Corps similar to that of the late army of occupation in France, (No. 21,) and have followed the subject through its various details, so as to shew at one view all that, in their opinion, can be required in men, horses, ammunition, and stores. As this necessarily includes the consideration of small arm ammnnition, the observations on that head will be found in a subsequent part of the report.

Articles of Stores, which it may appear advisable to discontinue or modify.

18. With respect to such articles of ammunition or stores as the Sub-Committee consider that it would be advisable either to discontinue or modify, they reserve their observations till the conclusion of their report, when the subject of such articles of Battering Train equipment as may appear to require revision shall come under consideration.

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Duties of Artillery Officers attached to Drivers when with Field Batteries.

19. The Sub Committee, consider it to be very essential that a fixed principle should be established with regard to the duties of Officers of Royal Artillery Drivers when serving with Field Batteries, beg to submit the following regulations on the subject.

The Officer attached to the Drivers of a Field Battery to have charge of the accounts of the same, taking care the Detachment is properly supplied with appointments and necessaries, and kept as complete as possible.

In exercising this duty, he is of course subject to the inspection and control of the Officer commanding the Battery, who will, at least once a month, examine the account books, state of debts and credits, &c., in order to ascertain that the service is carried on in a proper manner, and to his satisfaction.

A Battery, with its Men and Horses, to be always formed in three divisions, each under the command of an Officer; but the Officer of Drivers should not have charge of a division, except when the Company is incomplete in Subalterns.

The Driver Officer is to sit on courts-martial in his turn, and also to take his share of such other general service of the Battery as the Officer commanding the Battery may consider necessary.

He commands, of course, on all parades, when senior Officer, as he will also the Battery, when the Officers senior to him are absent, on leave, or otherwise.

(Signed) WILLIAM MILLAR,
Colonel, Royal Artillery.
" WILLIAM ROBE,
Colonel, Royal Artillery.
" AUGUSTUS FRAZER,
Lieut.-Colonel, Royal Horse Artillery.
" A. DICKSON,
Captain, R. H. Artillery, and Lieut.-Colonel.

Woolwich, 10th April, 1820.

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TABLE, No. 1.

Number and Species of Carriages of which a Horse Artillery or Field Battery of each nature is composed.

The original Table includes Batteries of the Heavy 5½-Inch Howitzer, and the Light 5½-Inch Howitzer, which have now been superseded by General Millar's 24-Pr. and 12-Pr. Howitzers, and are consequently here omitted: but a column has been added for the 32-Pr. Howitzer, proposed by Colonel Dundas, and introduced in 1848, to accompany the Medium 12-Pr. Brass Gun. The Heavy 6-Pr., the Heavy 3-Pr., and the 1-Pr. Mountain Gun, are also omitted from the enumeration of Ordnance forming the Field Artillery of the British service, published by authority, *account of changes, &c.*, 1847: but the data relating to the two former are here retained, for comparison with those of Guns in present use. The principal changes in the constitution of Field Batteries, since the date of this Report, are three in number. (1.) The substitution of a second Howitzer for one of the Guns, in 1852. (2.) The addition of a Rocket Section to each Troop of Horse Artillery, on converting the Rocket Troop into a Gun Troop in 1847. (3.) The introduction of the practice of carrying the spare wheels on the waggon perches, instead of on the spare Gun Carriage, which has made the latter available for other reserves. A Rocket Section has also been attached to each Field Battery sent on service in 1854, but this is not yet announced as a permanent arrangement.—*Ed.*

	Field Batteries.						Batteries.								
							Colonial.	Mountain.			Howitzer.				
Nature of Battery,.....	18-Pr.	12-Pr.	9-Pr.	6-*Pr. Hy.*	6-Pr. Lt.	3-*Pr. Hy*	3-Pr. Lt.	3-Pr. Draft.	3-Pr. Mules.		32-*Pr. Howitzer*	24-Pr. Howitzer		12-Pr. Howitzer.	
Nature of Howitzer,.....	8-In. Iron.	24-Pr. or Hy. 5½ In.	24-Pr. or Hy. 5½ In.	24-*Pr. or Hy. 5½ In.*	12-Pr.	12-*Pr.*	Coehorn.	Coehorn.	Coehorn.						
Rounds per Gun,.....	180	184	166	280	228	316	154	156	108						
Rounds per Howitzer,.....	112	144	144	144	236	286	80	96	72			144		286	
Number of Guns,.....	8	5	5		5		8	8	8			0		0	
Number of Howitzers,.....	1	1	1		1		1	1	1			6		6	
Gun Ammunition Waggons,.....	9	10	7		6		6 Carts	0	0			0		0	
Howitzer Ammunition Waggons,	4	2	2		2		2 Carts	0	0			12		12	
Spare Carriage,.....	1	1	1		1		0	0	0			1		1	
Forge Waggon,.....	1	1	1		1		0	0	0			1		1	
Store Waggon,.....	2	2	1		1		0	0	0			2		2	
Platform Waggon,.....	1	0	0		0		0	0	0			0		0	
Store Cart,.....	1	1	1		1		0	0	0			1		1	
Total Carriages,.....	28	23	19		18		12	4	4			23		23	

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TABLE, No. 2.

Ammunition which can be carried in the Boxes of Field Guns and Howitzers, with the number of Waggons required to convey the proportion of Ammunition judged necessary to accompany each Battery.

The tables for natures of Ordnance no longer in the service are omitted.—Ed.

Field Batteries.

	Round	Case of 41 Balls.	Spher. Case.	Total.	
18-*Pounder Iron on Field Carriage.*					
180 Rounds per Gun. 9 Waggons per Battery.					
Waggon { 2 Limber Boxes	12	6	6	24	N. B.—The partitions, which in 1st and 2nd Waggons, are packed with Common Case, are in the 3rd Waggon to be packed with Round.
Waggon { Body { Fore Box	12	0	6	18	
Waggon { Body { Hind Box	18	0	0	18	
	42	6	12	60	
Second Waggon	42	6	12	60	
Third Waggon	48	0	12	60	
Total per Gun	182	12	36	180	
Medium 12-*Pounder Brass.*					
184 Rounds per Gun. 10 Waggons per Battery.					
Gun Limber 3 Boxes	12	6	6	24	
Waggon { Limber 2 Boxes	18	4	10	32	
Waggon { Body { Fore Box	12	0	12	24	
Waggon { Body { Hind Box	24	0	0	24	
	66	10	28	104	
Second Waggon	54	4	22	80	
Total per Gun	120	14	50	184	
9-*Pounder Brass.*					
166 Rounds per Gun. 7 Waggons per Battery.					
Gun Limber 2 Boxes	18	8	6	32	
Waggon { Limber 2 Boxes	18	8	6	32	
Waggon { Body { Fore Box	24	0	8	32	
Waggon { Body { Hind Box	32	0	0	32	
	92	16	20	128	
2 Waggons for the five Guns, 148 Round, 16 Case, 28 Spherical. Total 192. Per Gun	29	3	5	38	
Total per Gun	121	19	25	166	

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FIELD BATTERIES *(continued.)*

Light 6-Pounder.	Round	Case of 41 Balls.	Spher. Case.	Total.
223 Rounds per Gun. 6 Waggons per Battery.				
Gun Axletree 1 Box*	3	3	0	6
Gun Limber 2 Boxes	24	8	8	40
Waggon { Limber 2 Boxes	32	8	8	48
Waggon { Body { Fore Box	35	0	10	45
Waggon { Body { Hind Box	55	0	0	55
	149	19	26	194
1 Waggon for the five Guns, 122 Round, 8 Case, 18 Spherical. Total 148. Per Gun	23	2	4	29
Total per Gun	172	21	30	223

* The six Cartridges for these Rounds are carried in the Limber Boxes, 8 Cartridges in each.

COLONIAL BATTERIES.

Light 3-Pounder of 4 feet, to travel Single Horsed.	Round	Case.	Total.
154 Rounds per Gun. 6 Carts per Battery.			
Gun Limber and Axletree 2 Boxes ...	23	11	34
Cart..... { 1st. Box	21	9	30
Cart..... { 2nd. Box	30	0	30
	74	20	94
Second Cart	51	9	60
Total per Gun	125	29	154

$4\frac{2}{5}$-*Inch Howitzer, Single Draft.*	Shells.	Case.	Total.
80 Rounds per Howitzer. 2 Carts to each.			
Howitzer Limber 1 Box	12	4	16
Cart 2 Boxes { 1st. Box	12	4	16
Cart 2 Boxes { 2nd. Box	16	0	16
	40	8	48
Second Cart	28	4	32
Total per Howitzer	68	12	80

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MOUNTAIN BATTERIES.

3-Pounder, of 2¼ Cwt., carried on Mules' Back.	Round	Case.	Total.
108 Rounds per Gun.			
1st. Mule to carry the Gun.			
2nd. Mule for the Carriage.			
3rd. Mule 2 Boxes	46	8	54
4th. Mule 2 Boxes	46	8	54
Total per Gun	92	16	108

3-Pounder, of 2¼ Cwt., with Shafts hooked to the Trail.			
156 Rounds per Gun.			
2 Mules in length, each carrying 2 Boxes, with 10 Round and 2 Case.			
4 Boxes	40	8	48
1st. Mule for Ammunition 2 Boxes ...	46	8	54
2nd. Mule for Ammunition 2 Boxes ...	46	8	54
Total per Gun	132	24	156

$4\frac{2}{5}$-Inch Howitzer, on five Mules.	Shells.	Case.	Total.
72 Rounds per Howitzer.			
1st. Mule carries the Howitzer.			
2nd. Mule carries the Carriage.			
3rd. Mule 2 Boxes Ammunition	20	4	24
4th. Do. Do.	20	4	24
5th. Do. Do.	20	4	24
Total per Howitzer	60	12	72

$4\frac{2}{5}$-Inch Howitzer, Shafts fixed to Trail.			
96 Rounds per Howitzer.			
2 Draft Mules, each carrying 4 Boxes.			
4 Boxes	20	4	24
2 Pack Mules 4 Boxes	40	8	48
3rd. Mule 2 Boxes	20	4	24
Total per Howitzer	80	16	96

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Howitzer Batteries.

	Spherical.	Case.	Shells.	Car casses.	Total.
8-*Inch Howitzer.*					
112 Rounds per Gun. 4 Waggons to each.					
Waggon — 2 Limber Boxes	6	...	6	...	12
Waggon — Body — Fore Box	7	1	...	...	8
Waggon — Body — Hind Box	...	2	6	...	8
	13	3	12	...	28
Three other Waggons similar	39	9	36	...	84
Total per Howitzer	52	12	48	...	112
* **32-*Pounder Howitzer.***					
24-*Pounder Howitzer.*					
144 Rounds per Howitzer. 2 Waggons to each.					
Howitzer Limber 2 Boxes	12	4	8	...	24
Waggon — Limber 2 Boxes	12	4	8	...	24
Waggon — Body — Fore Box	18	...	...	...	18
Waggon — Body — Hind Box	...	...	16	2	18
	42	8	32	2	84
Second Waggon	30	4	24	2	60
Total per Howitzer	72	12	56	4	144
12-*Pounder Howitzer.*					
236 Rounds per Howitzer. 2 Waggons to each.					
Howitzer Limber 2 Boxes	18	4	14	...	36
Waggon — Limber 2 Boxes	18	4	14	...	36
Waggon — Body — Fore Box	32	...	...	...	32
Waggon — Body — Hind Box	...	...	28	4	32
	68	8	56	4	136
Second Waggon	50	4	42	4	100
Total per Howitzer	118	12	98	8	236

* This piece has been introduced since the date of the Report, and is merely named to complete the list. —*Ed.*

When Batteries are composed wholly of Howitzers, there will be for each piece as follows:—

Howitzer Batteries.

	Rounds per Howitzer.
8-Inch Iron, 4 Waggons to each	112
24-Pr., or 5½-Inch Heavy, 2 Waggons to each ...	144
12-Pr., 2 Waggons to each	236

A Table for the 1-Pounder Amuzette follows in the original.—*Ed.*

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(Note by the Editor, to Table No. 2.)

At the date of this Report, the 24-Pr. was the heaviest Gun known to the British service, and this piece, although still to be met with in a few Garrisons, was considered to be almost obsolete. Since 1820, it has been re-instated in the list of Guns in use, and the 8-Inch and 10-Inch Guns of the late General Millar, the 68-Pr. of Colonel Dundas, and the 56-Pr. of Mr. Monk, have been added to it. The tendency of the day being to increase the weight of all armaments, we may contemplate the probability of the employment of a heavier Gun than the 18-Pr. of the Committee, for Field Batteries of Position. If an 18-Pr. of 38 cwt. can follow an army, there is little doubt that a 24-Pr., intermediate, perhaps, between the present 9′ and 6′ 6″ Guns of that calibre, which weigh 50 cwt., and 33 cwt. respectively; or the 32-Pr. of 42 cwt. or of 45 cwt.—could equally do so. We have had recent proof of the powerful effect of such Artillery in the Field, as employed by our opponents—we may be led to its employment ourselves. There are no Tables of Equipment extant for such Batteries: it may be mentioned, however, that to complete 180 rounds per Gun, in the proportions allotted to the 18-Pr., would require the transportation of about 51 cwt. of ammunition with each piece in the case of the 24-Pr.; and about 65 cwt. in the case of the 32-Pr.: an incumbrance, which can hardly fail to restrict their use within very narrow limits.

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TABLE, No. 3.

Strength and disposal of a Company of Artillery for Field Service.

A Company of Artillery, as usually sent on Foreign Service, (1820, *Ed.*) consists of :—

1 Captain.	3 Corporals.
1 2nd. Captain.	6 Bombardiers.
2 1st. Lieutenants.	90 Gunners.
1 2nd. Lieutenant.	2 Drummers.
3 Serjeants.	
	Total, 109

Leaving an establishment at home, applicable to Recruiting, Drill, Field and Staff Officer's Servants, Office Clerks, and other duties.

Of these the following will be the usual appropriation :—

	Captains.	Subalterns.	Serjeants.	Corporals.	Bombardiers.	Gunners.	Drummers.	Total.
1 N.C. Officer and 10 Gunners per Gun, forming 6 Sub-Divisions,	...	...	...	...	6	60	...	66
3 Divisions of two Guns each, and for general service of the Battery, ...	2	3	1	2	...	...	1	9
To act as Serjeant-Major, ...	...	...	1	...	...	...	...	1
Officers' Servants, including the Surgeons', ...	...	...	...	...	...	6	...	6
	2	3	2	2	6	66	1	82
With the Waggon Division, consisting of the Forge, Spare Carriage, Store Waggon, and the Ammunition not taken into the first Line.	...	...	1	1	...	24	1	27
Total, ...	2	3	3	3	6	90	2	109

Of the 24 Gunners with the Waggon Division.

There are occasionally employed as	Tailors,	1 or 2
	Shoe-makers,	1
	Wheelers,	1
	Collar-makers,	1
	Smith,	1
Guard, and occasional Escort to Small Arm Ammunition of the Division of Infantry, ...		3
Recommended men for promotion, generally acting as Bombardiers,		2
Occasional Escorts of Ammunition and Stores from the Depot,		3
To replace casualties in the Gun Detachments, which must be kept always complete, ...		11
		24

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(Note by the Editor.)

The foregoing Table accounts for little more than one-half of the strength of a Company, as attached to a Field Battery for Foreign Service at the present day, the difference is to be found in the portion of the Company representing the former Driver Detachment, as will be seen in the next Table. Taking the strength of a Company, and of a Troop of Horse Artillery as they are now employed in the Field, (December 1854,) the numbers may be thus accounted for.

9-Pr. Battery, Horse Artillery.	
Officers, including Assistant-Surgeon, ...	6
Staff-Serjeants, ...	2
Four Mounted N.C. Officers to each Division of 2 Guns, and 1 to the Rocket Section, ...	13
Two Limber Gunners per Sub-Division,	12
Six Mounted Gunners per Gun, ...	36
One Trumpeter, 1 acting do. mounted, ...	2
One Farrier, 3 Shoeing-Smiths, 2 acting do. mounted, ...	6
Two Collar-makers ; 1 Wheeler, 1 acting do.	4
Spare Gunners, to replace casualities, furnish Guards, Escorts, and take general duties, including the Tailors, and 2 acting Collar-makers, ...	24
Officer's Servants and Grooms, ...	12
Drivers for 6 pieces of Ordnance, ...	24
Id. for 4 Gun and 2 Howitzer Ammunition Waggons of first line, ...	18
Id. for 3 Howitzer and 2 Gun Ammunition Waggon additional, ...	13
Id for Rocket Carriage, Forge, Store Limber Waggon, Store Cart, Spare Gun Carriage, ...	15
Id. in charge of Spare Horses, to replace casualities, &c., ...	19
Total, ...	206
Horses.	
Riding, ...	76
Spare, Riding, ...	8
Draught, ...	140
Spare, Draught, ...	20
	244
Carriages, ...	22

9-Pr. Battery, Field Artillery, (Foot.)	
Officers, including Assistant-Surgeon, ...	6
Staff Serjeants mounted, ...	2
Other N.C. Officers mounted 8, dismounted 6, ...	14
Six Gun Detachments, exclusive of 1 N.C. Officer to each, ...	48
Trumpeters, ...	2
Artificers.—1 Farrier, 1 Shoeing-Smith mounted; 4 Shoeing-Smiths, 2 Wheelers, 2 Collar-makers dismounted, ...	10
Officer's Servants and Grooms, ...	12
Drivers for 6 pieces of Ordnance, ...	24
Id. for 4 Gun and 2 Howitzer Ammunition Waggons of the first line, ...	18
Id. for 3 Howitzer and 2 Gun Ammunition Waggons additional, ...	15
Id. for Rocket Carriage, Forge, Store Limber Waggon, Store Cart, Spare Gun Carriage, ...	13
Gunners and Drivers in charge of spare Horses, to replace casualties, furnish Guards, Escorts, small arm Ammunition Detachments, Tailors, and take all other duties, ...	50
Total, ...	214
Horses.	
Riding, ...	26
Spare, Riding, ...	4
Draught, ...	140
Spare, Draught, ...	16
	186
Carriages, ...	22

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TABLE, No. 4.

Establishment of Batteries.

Note by the Editor.—Tables 4 to 17 of the original, contain details of the establishment of every nature of Field Battery for Foreign and Home Service. The basis of the entire arrangement having been changed, by the abolition of the Corps of Drivers, it is thought sufficient to present the general totals, under each head, in the two following tables.

Table A. Foreign Service.

Tables.	Nature of Battery.	No. of Carriages.	Royal Artillery.				Royal Artillery Drivers				Horses and Mules.			
			Officers.	N.C. Officers & Drummers.	Gunners.	Total.	Officers.	N.C. Officers & Trumpeters	Artificers.	Drivers.	Total.	Draught.	Riding.	Baggage.	Total.
4	18-Pr. Gun of Position...	23	6	14	90	110	1	10	10	102	123	170	20	8	198
5	12-Pounder Medium.....	23	6	14	90	110	1	10	10	99	120	164	20	8	192
6	9-Pounder	19	6	14	90	110	1	9	10	84	104	137	19	8	164
7	6-*Pounder Heavy*.....	18	6	14	90	110	1	9	10	81	101	131	19	8	158
8	6-Pounder Light.....	18	6	14	80	100	1	8	9	73	91	117	18	8	143
9	3-*Pounder Heavy*.....	17	6	14	80	100	1	8	9	70	80	111	18	8	137
	Colonial Service.														
10	3-Pounder Light.....	12	1	4	20	25	...	1	1	14	16	26	...	...	26
11	1-Pounder of 5 feet.....	9	1	4	20	25	...	1	1	11	13	20	...	...	20
	Mountain Service.														
12	3-Pr. on Mules' Back.....	5	1	5	25	31	...	2	1	20	23	30	1	1	32
13	3-Pounder Draught.....	5	1	5	21	27	...	2	1	19	22	29	1	1	13
	Rl. Horse Artillery.														
14	12-Pounder Medium.....	25	6	16	96	118	...	...	12	93	105	160	79	7	246
15	9-Pounder	19	6	15	90	111	...	...	11	80	91	135	78	7	220
16	6-Pounder Light.....	18	6	14	80	100	...	...	9	69	78	115	64	7	186
17	3-*Pounder Heavy*.....	17	6	14	80	100	...	...	9	65	74	108	64	7	179

Table B. Home Service.

4	18-Pr. Gun of Position...	...	...	...	...	...	...	7	6	47	61	74	14	...	88
5	12-Pounder Medium.....	14	5	14	72	91	1	7	6	47	61	74	14	...	88
6	9-Pounder	14	5	14	72	91	1	7	6	47	61	74	14	...	88
7	6-*Pounder Heavy*.....	14	5	14	72	91	1	7	6	47	61	74	14	...	88
8	6-Pounder Light.....	14	3	9	60	72	...	7	6	36	49	61	12	...	73
9	3-*Pounder Heavy*.....	14	3	9	60	74	...	7	6	36	49	61	12	...	73
	Colonial Service.														
10	3-Pounder Light.....	...	...	...	...	...	...	...	...	...	...	...	...	...	...
11	1-Pounder of 5 feet.....	...	..	...	...	...	...	...	...	...	...	...	...	...	...
	Mountain Service.														
12	3-Pr. on Mules' Back.....	...	...	...	...	...	...	...	...	...	...	...	...	...	...
13	3-Pounder Draught.....	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	Rl. Horse Artillery.														
14	12-Pounder Medium.....	15	6	14	84	104	...	...	8	42	50	77	73	..	150
15	9-Pounder	15	6	14	80	100	...	...	8	42	50	77	73	...	150
16	6-Pounder Light.....	14	6	14	70	90	...	...	8	34	42	62	63	...	125
17	3-*Pounder Heavy*.....	14	6	14	70	90	...	...	8	34	42	62	63	...	125

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TABLE, No. 18.

Proportion of Ordnance, Carriages, Ammunition, Implements, and Stores, required for a Field Battery of each Nature for Foreign Service.

Table No. 1, page 191, gives the whole of the information contained in this Table. It allots 3 Ammunition Waggons to each 18-Pr. Gun; 2 Waggons to each 12-Pr. Medium; 7 Waggons to 5 9-Pr. Guns; 6 Waggons to 5 6-Pr. Guns, and 1 Waggon to each 3-Pr. Gun. In the late equipment, which was prepared for a distant seat of war, and a country wanting in means of transport, 6 Ammunition Waggons have been allotted to 4 9-Pr. Guns, and 5 Waggons to 4 Light 6-Pr. Guns.

The same Table gives 4 Ammunition Waggons to each 8-Inch Howitzer, and 2 Waggons to each 24-Pr. or 12-Pr Howitzer. In the late equipment, 5 Ammunition Waggons are allotted to two 24-Pr. Howitzers, and 4 Ammunition Waggons to two 12-Pr. Howitzers.—*Ed.*

		18-Pounder Iron.	12-Pounder Medium.	9-Pounder.	6-Pounder Heavy.	6-Pounder Light.	3-Pounder Heavy.	8-Inch Howitzer Iron.	24-Pounder Howitzer.	12-Pounder Howitzer.	Total Ordnance.	Ammn. Lr. Waggons.	Forge Waggons.	Spare Carriages.	Store Waggons.	Store Cart.	Platform Waggon.	Total Ordnance and Waggon.
Ordnance, and Carriages for a Field Battery of each nature.	18-Pounder Iron,.....	3	...	...	...	...	...	1	...	...	4	13	1	1	2	1	1	23
	12 Pounder Medium,.....	...	5	...	...	...	...	...	1	...	6	12	1	1	2	1	...	23
	9-Pounder,.....	...	...	5	...	...	...	...	1	...	6	9	1	1	1	1	...	19
	6-*Pounder Heavy*,.....	...	...	...	5	...	...	...	1	...	6	8	1	1	1	1	...	18
	6-Pounder Light,.....	...	...	...	...	5	...	...	...	1	6	8	1	1	1	1	...	18
	3-*Pounder Heavy*,.....	...	...	...	...	...	5	...	...	1	6	7	1	1	1	1	...	17

Disposal of the Ammunition Waggons.

18-Pr. Battery,	18-Pounder 8 Waggons 9 8-Inch Howr. 1 do. 4	13	Waggons	Rounds per Gun,	162
				do. per Howitzer,	112
12-Pr. M. Battery,	12-Pr. Medium 5 do. 10 24-Pr. Howr. 1 do. 2	12	do.	do. per Gun,	178
				do. per Howitzer,	144
9-Pr. Battery,	9-Pounder 5 do. 7 24-Pr. Howr. 1 do. 2	9	do.	do. per Gun,	163
				do. per Howitzer,	144
6-Pr. Hy. Battery,	6-Pr. Heavy 5 do. 6 24-Pr. Howr. 1 do. 2	8	do.	do. per Gun,	230
				do. per Howitzer,	144
6-Pr. Lt. Battery,	6-Pr. Light 5 do. 6 12-Pr. Howr. 1 do. 2	8	do.	do. per Gun,	220
				do. per Howitzer,	220
3-Pr. Hy. Battery,	3-Pr. Heavy 5 do. 5 12-Pr. Howr. 1 do. 2	7	do.	do. per Gun,	316
				do. per Howitzer.	220

Proposed Scale in 1820.			*Scale adopted in* 1854.—*Ed.*		
Rounds per Gun,	9-Pounder,	163	Rounds per Gun,	9-Pounder,	176
	6-Pounder,	220		6-Pounder,	231
Rounds per Howitzer,	24-Pounder,	144	Rounds per Howitzer.	24-Pounder,	174
	12-Pounder,	220		12-Pounder,	236

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TABLE, No. 19.

One Piece of Ordnance of each Nature, with proportion of Implements required therewith.

The following Table is altered in form from the original, by taking the articles in the alphabetical order in which they are enumerated, in the FORM OF DEMANDS, &c., FOR HOME SERVICE, given in the Appendix III., to the Field Battery Exercise Book, 1858. A separate column is given in the original for each nature of Ordnance, and each Carriage of a Field Battery; as the numbers are the same in every case, with a few exceptions, which are duly noted below, they are here given once for all. The following articles are omitted in this Table that are given in the original, but are now no longer supplied :—

Fuze Augurs.
Iron Compasses.
Tin Grease Boxes.
Handscrew Jacks.
Brass Gun Locks.
Pieces of 2-Inch Rope, 10 yards.
Box Rides.
Wadmiltilts.

	Ord	Wag
Axes. Felling	1 *a*	1
Axes. Pick	1 *a*	1
Bags, Canvas for Fuzes, *Striped, with Straps*	1 *c*	
Bags, Canvas for Fuzes, *Yellow, with Straps*	1 *c*	
Bills, Hand	1 *a*	1
Boxes. Grease Tin	1	1
Boxes. Fuze White 0·4	*d*	
Boxes. Fuze Blue 0·6	1	
Boxes. Fuze Black 0·8	1	
Buckets, Leather	2 *a*	2
Cartouches, Canvas	4 *c*	9
Couples for Traces, Spare	2 *c*	2
Corn Bags for 2 days Corn	*h*	*h*
Covers *Painted, Gun Lock*	*c*	
Covers Limber Box	2 *d*	2
Covers Waggon Box	*d*	2
Cork Screws	1	
Cutters, Portfire	1	
Drag-Ropes, New Pattern	1 *c*	
Files, Tenon, Saw	2 *e*	
Fitting-Ropes	*c*	
Flints, Gun, a proportion		
Forage Cords	*h*	*h*
Funnels, Tin	1 *e*	
Grease, Firkins, per Battery,	½	
Handspikes Common	*f*	
Handspikes Traversing	2	
Hammers Claw	1	
Hammers Wrench	1 *g*	
Heads Spare Rammer	1	
Heads Spare Spunge	1	
Hambro' Line, Skeins		1
Harness Wheel	2	2
Harness Lead	*hh*	*hh*
Headstall Collars and Chain Reins	*hh*	*hh*
Hooks, Reaping or Sickles,	*h*	*h*
Irons, Priming, Sets	1	
Jacks, Lifting		1
Kettles, Camp	*c*	

	Ord.	Wag
Knives, Laboratory	1 *i*	
Linch-pins, Spare	2	1
Lintstocks	*p*	
Leggings	*h*	*h*
Mauls, Wooden		1
Mallets, 5½ Inch	1	
Marline, Skeins		1
Men's Harness Heavy	*p*	
Needles, Stitching	2 *c*	
Nose-Bags, Canvas	*hh*	*hh*
Padlocks, with Keys	3	4
Pickets		4
Punches for Vents	2	
Pincers Fuze-Iron	1 *e*	
Pincers Iron, Pairs	*g*	
Powder-Horn	*p*	
Prolonges, Heavy	1 *k*	
Pockets Tube, Leather	1	1
Portfire-sticks	2	
Primers, Tin Funnel	1 *e*	
Quadrant and Perpendicular	*p*	
Rasps, for Howitzer only,	1 *e*	
Rope, Tarred 3-Inch—yards	25	
Rules, 1 foot measuring		
Saws Hand	*g*	
Saws *Sash*, 3 for a Battery	*c*	
Sawsets	1 *c*	
Setters, Wood 5½-Inch	*l*	
Scissors, Small	1	
Spunges	2 *l*	
Spikes Spring	1 *m*	
Spikes Common	2	
Scrapers, Shell, 1 per Howitzer,	1 *e*	
Spades	2 *n*	2
Tents complete, 1 per 12 Men,	*e*	
Thumbstalls	2 *e*	
Wadhooks	1 *o*	
Washers, Spare	1	1
Wheels, Spare, 1 per Waggon,	*g*	
Whips	*h*	*h*

(*a*) 18-Pr. and 8-Inch Howitzer carry 1 or 2 more.—(*b*) 3-Pr. none: the use of Shrapnel for this Calibre not being recommended.—(*c*) This article is not in the Committee's List.—(*d*) This article is discontinued.—(*e*) None to 18-Pr., 8-Inch Howitzer, or 3-Pr.—(*f*) 18-Pr. to carry 4.—(*g*) See the latter part of the Table, under Spare Carriages, one is now carried per Gun.—(*h*) One to each Driver.—(*hh*) Two to each Driver.—(*i*) This article is called cutting-knife and saw in one, a pattern now unknown.—(*k*) None to 18-Pr. or 8-Inch Howitzer.—(*l*) Two to each Gun and Howitzer.—(*m*) Two to the 18-Pr. and 8-Inch Howitzer.—(*n*) Four to the 8-Inch Howitzer.—(*o*) None to the Howitzer.—(*p*) Carried with the 18-Pr. and 8-Inch Howitzer only. No Intrenching Tools are alloted to the Store Limber Waggon or Store Cart, which, however, at present carry them.

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(Additional Note on Gun Locks.)

The introduction of Friction Tubes has superseded the necessity for the use of Gun Locks: but the following remark, by the late Sir Alexander Dickson, extracted from a letter, dated Valenciennes, 18th April, 1818, and addressed to the late Sir Augustus Frazer, will be read with much interest:—

"With respect to its being applied to the service of Artillery in the Field, I feel satisfied that Locks would be of essential service with Field Guns in all ordinary duties, such as Reviews, Firing Exercise, and Salutes, and in all service in the Field when not too closely engaged, the Lock being sufficiently certain in these situations, the saving of Portfires would speedily repay the expense of supplying each Gun with a good Lock. It would save the trouble, also, of continually lighting and cutting Portfires, and there would be far less risk in firing amongst ripe corn or dry grass: the setting fire to country more generally arises from the Portfire than from the discharge, but although it would diminish the expenditure of Match and Portfires, I would not, on that account, sanction the conveyance of a less quantity than the present in use, for in close action the Lock could not be depended on, and in bad weather it could not be used: but, allowing these Portfires and Matches to be thus carried, I feel convinced that many Brigades in a Campaign would not use a quarter of them; as the proportion, however, as at present, would take up but little room, and as these articles could travel for seven years without injury, there could be no objection to their continuance in toto, as the only augmentation of material would be the Lock and a few Flints."—*MSS. Ed.*

TABLE, No. 19, *continued.*

Stores carried with each of the Waggons accompanying a Field Battery of each Nature.

		18-Pounder Iron.	12-Pr. Med. or Light.	9-Pr., or 6-Pr. Heavy.	6-Pounder Light.	3-Pounder Heavy.	8-Inch Howitzer.	24-Pr. or 5½-Inch Howitzer.	12-Pounder Howitzer.
Forge Waggon for each Field Battery, ...		1	1	1	1	1			
With the Forge Waggon.	Bellows, Pair	1	1	1	1	1			
	Anvil with Block, ...	1	1	1	1	1			
	Coals, Bushels	2	2	2	2	2		Smiths' Tool-Chest not required.	
	Smiths' Tools in the Limber Box, consisting of:—								
	Tongs, Pairs	2	2	2	2	2			
	Slice, ...	1	1	1	1	1			
	Ladle, ...	1	1	1	1	1			
	Vices, Standing, ...	1	1	1	1	1			
	Vices, Hand, ...	1	1	1	1	1			
	Hammers, Sledge, ...	1	1	1	1	1			
	Hammers, Hand, ...	1	1	1	1	1			
	Hammers, Riveting, ...	1	1	1	1	1			
	Cold Chisels, Rod, ...	2	2	2	2	2			
	Cold Chisels, Hot, ...	2	2	2	2	2			
	Punches, Hot, ...	2	2	2	2	2			
	Punches, Cold, ...	2	2	2	2	2			
	Screw Drivers, ...	1	1	1	1	1			
	Files, Half Round, or 14-Inch	6	6	6	6	6			
	Files, Round, „ 12 „ 5	6	6	6	6	6			
	Files, Flat, „ 10 „ 12	6	6	6	6	6			
	Files, Three Square, 8 „ 8	6	6	6	6	6			
	Shoeing Tools, one Set for each Smith, ...	1	1	1	1	1			

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TABLE, No. 19, *continued.*

		18-Pounder Iron.	12-Pr. Heavy or Light.	9-Pr. or 6-Pr. Heavy.	6-Pounder Light.	3-Pounder Heavy.
Spare Gun Carriage *and Wheel Carriage*, ...		1	1	1	1	1
With the spare Gun and Wheel Carriage.	*Wheel*, *Heavy*, ...	1	1	1	...	..
	Limber, ...	1	...	...	...	...
	Light, ..	3	...	...	3	3
	Iron Axles, Whole-Heavy,	1	...	...	...	...
	Arms Light, ..	2	2	2	2	2
	Handspikes, Common, ...	16	...	...	...	...
	Traversing, ...	2	2	2	2	2
	Shafts complete, ...	2	2	2	2	2
	Pintails, ...	1	1	...	...	...
	Limber Hooks, ...	1	1	1	1	1
	Driving Bolts, ...	1	1	1	1	1
	Perches, ...	1	1	1	1	1
	Nose Plates, ...	1	1	1	1	1
	Trail Plate Eyes, ...	1	1	1	1	1
	Elevating Screws, ...	1	1	1	1	1
	Staples for side Arms, ...	...	20	20	20	20
	Linch Pins, Heavy, ...	4	6	6	...	...
	Light, ...	10	10	10	8	8
	Wheelers' Tools in Limber Box :					
	Wheelers' *Tool-chest* not required					
	Pincers, pairs	1	1	1	1	1
	Broad Axes, ...	1	1	1	1	1
	Adzes, ...	1	1	2	1	1
	Draw Shaves, ...	1	1	1	1	1
	Spoke Shaves, ...	2	2	2	2	2
	Hammers, Shoeing, ...	1	1	1	1	1
	Rivetting, ...	1	1	1	1	1
	Claw, ...	1	1	1	1	1
	Drive-Pins, ...	2	2	2	2	2
	Hand Punches, ...	2	2	2	2	2
	Cold Chisels, Hand, ...	2	2	2	2	2
	Augers, 1-Inch, ...	2	2	2	2	2
	¾ do.	1	1	2	1	1
	½ do.	1	1	2	1	1
	Spike Bits of Sorts, ...	4	4	2	4	4
	Gimblets, ...	1	1	18	1	1
	Planes, Jack, ...	1	1	1	1	1
	Smoothing, ...	1	1	5	1	1
	Wrench Hammers, Strong, ...	1	1	1	1	1
	Saws, Hand, ...	1	1	1	1	1
	Tenon, ...	1	1	1	1	1
	Iron Crows, 2 feet, ...	6	6	18	6	6
	Saw Files, Hand, ...	6	6	12	6	6
	Tenon, ...	1	1	1	1	1
	Rules, 2 feet, ...	1	1	1	1	1
	Gouges, Picking, ...	1	1	2	1	1
	Boxing,* ...					

Note by the Editor.—The Spare Wheels being no longer carried on the Spare Gun Carriage, its load has been completed for the late expedition, with the following articles.

	Pr. 12	Pr. 9	Pr. 6
Spunges,	2	2	2
Swingletree,	1	1	1
Wadhooks,	1	1	1
Drag-Chain,	...	...	...
Eye-Bolts,	1	1	1
Handspike Loops	1	1	1
Handspike Shoes,	1	1	1
Screws, 2-inch,	66	66	66
Do. 1½-inch,	66	66	66
Do. ¾-inch,	68	68	68
Washers, Heavy	3	2	...
Do. Light		12	4
Kettles, Camp	2	2	2
Buckets,	2	2	2
Felling Axes,	1	1	1
Pick Axes,	1	1	1
Bill Hooks,	1	1	1
Spades,	2	2	2
Handspikes,		2	
Limber, Light,		1	
Linch-pins,		8	
Perches,		1	
Shafts, pairs,		1	
Screw, Elevating,		1	

* *Tools continued.*

Bevils, Steel Blade,	1
Buzzes, Wheelers,	2
Chisels, Rimer,	4
,, Hot,	2
Compasses, Smiths,	1
Files, Bastard,	3
Gouges, Scribing,	4
Gauges,	2
Mallets,	1
Pencils, Blacklead,	12
Pots, Glue,	1
Rasp, ½ Round,	1
Saws, Turning,	1
Sets, Saw,	1
Squares of sorts,	3
Stocks,	1
Stones, Rub,	1

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TABLE, No 19, *continued.*

			18-Pounder Iron.	12-Pr. Medium Light.	9-Pr. or 6-Pr. Heavy.	6-Pounder Light.	3-Pounder Heavy.	
With the spare Gun and Wheel Carriage. (*Continued.*)	Screw Drivers, strong		1	1	1	1	1	
	Linch Pins,		12	12	12	12	12	
	Compasses, pairs		1	1	1	1	1	
	Rag Stones,		1	1	1	1	1	
	Oil Stones,		1	1	1	1	1	
	Tool Bags,		1	1	1	1	1	
	Chalk Lines,		1	1	1	1	1	
	Brass Reels,		1	1	1	1	1	
	Socket Chisels,	2-Inch,	1	1		1	1	*7Chisels of sorts now furnished. *Ed.*
		1½ do.	1	1		1	1	
		1 do.	1	1	*	1	1	
		¾ do.	1	1		1	1	
		½ do.	1	1		1	1	
	Gin complete with Blocks, Sling, and Fall,		1	...	...	...	...	
Store Limber Waggon,			...	...	...	1	1	
With the Store Waggon.	Tarred Rope, 3-Inch—yards,		25	25	25	25	25	
	Lashing Rope, Coils,—yards		1	½	25	25	25	
	Grease, Kegs,		8	8	8	8	8	
	Iron, Cwt.	Flat,	¼	¼	¼	¼	¼	
		Square,	¼	¼	¼	¼	¼	
		Rod,	¼	¼	¼	¼	¼	
		Round,	¼	¼	¼	¼	¼	
		Hooping,	¼	¼	¼	¼	¼	
	Steel, Cwt.	Sheer,	¼	¼	¼	¼	¼	
		Blister,	¼	¼	¼	¼	¼	
	Horse Shoes, Sets, 3 Nails to each,		40	40	40	40	40	
	Lanthorns, Dark,		3	3	3	3	3	
	Candles, lbs.		12	12	12	12	12	
	Spare,	Leather Buckets,	6	6	6	6	6	$\frac{1}{10}$ the No. of Horses.
		Nose Bags,	...	...	..	...	...	
		Forage Cords, Sets,	6	6	6	6	6	
		Reaping Hooks,	6	6	6	6	6	
	Scythes,		6	6	6	6	6	1 to each Scythe,
	Rag Stones, for Scythes,		6	6	6	6	6	
	Spare Gun Wheels,	Heavy,	...	...	1	1	...	
		Light,	1	...	..	1	1	
	Spare in the rough,	Felloes of sorts,	12	9	4	9	9	
		Spokes,	24	18	2	18	18	
		Splinter Bars,	1	1	1	1	1	
	Streak of sorts,		9	6	6	6	6	
	Copper Powder Measures, Sets 4 lbs. to ¼ lb.		2	1	1	1	1	For weighing Forage, Provisions, &c.
	Steel Yard, with Weights to weigh 2 cwt.		2	1	1	1	1	
	Collar-makers' Materials,		...	...	...	...	...	
	Hides,	Black, Heavy,	...	1	1	2	1	1
		Black, Light,	...	1	1	2	1	1
		White,	...	1	1	2	1	1
		Brown,	...	...	...	1	...	...
		Bridle Brown,	...	...	...	1	...	...
		Saddle Seat,	...	...	...	1	...	...
	Brushes, Harness,		...	...	...	8	...	...

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TABLE, No. 19, *continued.*

		18-Pounder Iron.	12-Pr. Medium Light.	9-Pr. or 6-Pr. Heavy.	6-Pounder Light.	3-Pounder Heavy.
With the Store Waggon.	Basils, dozen Black,	3	3		2	2
	Basils, dozen Brown,	3	3	3	2	2
	Wax, lbs. Black,	4	4	4	2	4
	Wax, lbs. Bees,	2	2	2	2	2
	Thread, Collar,	6	6	6	4	4
	Thread, Hemp,	10	10	12	8	8
	Bristles, oz.	8	8	8	6	6
	Whip Cord, lbs.	2	2	4	2	2
	Whips, Short,	6	6		6	6
	Doe's Hair, lbs.	28	28	28	28	28
	Serge, yards,	20	20	20	20	20
	Girth Web, yards,	20	20	20	20	20
	Brushes, Hard,	12	12	12	12	12
	Oils, Gallons, Sweet,	¼	¼	¼	¼	¼
	Oils, Gallons, Neat,	10	10	10	8	8
	Straps for side Arms,	...	6	6	6	6
	Black Iron Buckles, 2-Inch,	2	2	12	2	2
	Black Iron Buckles, 1¾ do.	3	3	12	3	3
	Black Iron Buckles, 1½ do.	3	3	36	3	3
	Black Iron Buckles, 1 do.	3	3	72	3	3
	Black Iron Buckles, ¾ do.	3	3	36	3	3
	Screws of Sorts, dozen	8	8	8	8	8
	Nails, Streaks of sorts,	100	100	100	100	100
	Nails, Clasp, 40 Penny,	200	...	...	...	...
	Nails, Clasp, 40 ...	300	...	...	...	...
	Nails, Clasp, 30 ...	300	300	300	300	300
	Nails, Clasp, 20 ...	600	600	600	600	600
	Nails, Clasp, 6 ...	600	600	600	600	600
	Nails, Clout, the large sort, 6 ...	600	600	600	600	600
	Nails, Clout, the large sort, 4 ...	600	600	600	600	600
	Nails, Clout, the large sort, 3 ...	600	600	600	600	600
	Nails, Clout, the large sort, 2 ...	600	600	600	600	600
	Tacks of sorts,	1500	1000	14 lb	1000	100
	Collar-maker's Tools in the Limber Box consisting of:—					
	Lead for punching small,	1	1	1	1	1
	Saddlers' Hammers,	1	1	1	1	1
	Knives, Hand,	1	1	1	1	1
	Knives, Cutting,	1	1	1	1	1
	Mallets,	1	1	1	1	1
	Shears, pairs	1	1	1	1	1
	Clams, pairs	1	1	1	1	1
	Ragstones,	1	1	1	1	1
	Rules, 2 feet	1	1	1	1	1
	Marline Spike,	1	1	1	1	1
	Hand Iron,	1	1	1	1	1
	Needles, Collar,	6	6	6	6	6
	Needles, Sewing,	24	24	24	24	24
	Awls, Driving, Large,	1	1	1	1	1
	Awls, Driving, Small,	1	1	1	1	1
	Awls, Stitching of sorts,	12	12	12	12	12
	Punches,	1	1	1	1	1
	Pincers, pairs	1	1	1	1	1
	Nippers,	1	1	1	1	1
	Stuffing Sticks,	2	2	2	2	2

The following are the additions last made to this list, in equipping 9-Pr. Batteries :—

Buckles, 1¼-in.	36
Roller, pol. ⅞ „	36
„ Brass	42
Pans, Oil,	6
Thread Black, lbs.	1
Thread Brown, lbs.	1
Rope for Traces, pr.	2
Bits, Snaffle,	24
Lashes, Silk,	12
Bones, Saddlers,	2
Chisels,	2
Claws, Nail,	2
Creases,	6
Compasses,	2
Edge Tools,	6
Hafts, awl,	24
Hammers, Claw,	2
Hammers, Hand,	2
Hammers, Reveting,	2
Irons, Collar,	6
Irons, Edge,	2
Irons, Pricking,	6
Irons, Stuffing,	4
Needles, Sadlers,	200
Needles, Stitching	50
Needles, Quilting,	12
Pins, Iron,	2
Plyers,	2
Straps,	2
Spoke Shaves,	2
Steel Butchers,	2
Seam Turners,	2
Screw Drivers,	2
Thimbles,	4

Note.—It has been thought more important to make the slight alterations in the 9-Pr. list above, which make it agree with recent equipments, than to adhere to the Committee's numbers.

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TABLE, No. 19, *continued.*

Proportion of Ammunition and Laboratory Stores carried with a Field Battery of each Nature.

Note.—The details for the Heavy 6-Pounder and Heavy 3-Pounder are omitted.—Ed.

		With each Gun and Limber.							With each Ammunition Waggon.						
		18-Pounder.	12-Pounder.	9-Pounder.	6-Pounder Light.	8-Inch Howitzer.	24-Pounder Howitzer	12-Pounder Howitzer.	18-Pounder.	12-Pounder.	9-Pounder.	6-Pounder Light.	8-Inch Howitzer.	24-Pounder Howitzer.	12-Pounder Howitzer.
Shot,	Round,	...	6	16	27	...	...	...	36	54	70	122	...	...	...
	Case, Common,	...	6	8	11	...	4	4	6	4	8	8	3	4	4
	Case, Spherical,	...	6	8	8	...	12	20	12	22	16	18	13	30	48
Shells, Common, empty,		...	...	...	...	...	8	12	...	...	...	...	12	24	36
Carcases, Round, fixed,		...	...	...	...	...	...	...	...	...	...	...	3	2	4
Cartridges, Filled,	Charge, lbs.	...	4	3	1½	2½	2½	1¼	6	4	3	1½	4	2½	1¼
	Number	...	24	32	46	28	24	36	42	80	94	18	28	60	92
	Charge, lbs.	...	...	...	...	...	...	...	4½	...	...	...	...	...	...
	Number	...	...	..	...	...	...	...	12	...	...	...	...	...	...
	Burster, oz.	...	4½	3½	2½	...	10	5	5	4½	3½	2½	1·14	10	5
	Number	...	6	6	8	...	8	14	12	22	14	18	12	24	42
	Burster, oz.	...	...	...	...	...	6	4½	...	...	...	...	15	6	4½
	Number	...	...	...	...	...	12	18	...	...	...	...	13	30	50
	Empty,	...	...	...	...	...	...	...	100	100	100	100	100	100	100

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Ammunition and Laboratory Stores, Table 19 *continued.*

	With each Gun and Limber.								With each Ammunition Waggon.							
	18-Pounder.	12-Pounder.	9-Pounder.		6-Pounder Light.		8-Inch Howitzer.	24-Pounder Howitzer.	12-Pounder Howitzer.	18-Pounder.	12-Pounder.	9-Pounder.		6-Pounder Light.		8-Inch Howitzer.	24-Pounder Howitzer.	12-Pounder Howitzer.
Quick Match, a length of 10 yards in a clue, ...		...	...		...			...	...	1	1	1		1		1	1	1
Tubes, Copper, ...		100	100		100			100	100	100	100	100		200		800	100	100
Fuzes, For Spherical Case, *Cut*, 4 Tenths, ...		6	8		8			12	20	12	22	16		18		18	30	48
Fuzes, For Spherical Case, *Cut*, 6 „ ...		6	8		8			12	20	12	22	16		18		18	30	48
Fuzes, For Spherical Case, *Cut*, 8 „ ...		6	8		8			12	20	12	22	16		18		18	30	48
Fuzes, For Spherical Case, Uncut, ...		6	8		8			12	20	12	22	16		18		18	30	48
Fuzes, Common, graduated, ...		...	...		...			10	15	...	...	...		...		15	30	35
Portfires, ...		12	12		12			12	12	12	12	12		18		12	12	12
Slow Match, Skeins, ...		1	1		1			1	1	2	2	2		2		2	2	2

Note by the Editor.—A part of the articles enumerated in this part of the Table in the original, have been transferred to the Alphabetical List, at page 201. The partial substitution of Friction Tubes for common Tubes, has caused a considerable reduction in the number of Portfires; and since the introduction of Captain Boxer's Fuzes, the whole of these are carried uncut; nor is the Saw and Cutting Knife required for fitting them—all Fuze holes are reamed true, and the Fuzes fit with great precision.

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TABLE, No. 20.

Further proportion of General Stores, for Six Months' Consumption, of a Field Battery already Equipped.

This Table is copied without alteration.—*Ed*

	Field Battery.		
	18-Pounder.	Heavy.	Light.
Gin complete with Blocks, Sling and Fall, ...	1	...	...
Claw Hammers, ...	2	2	2
Intrenching Tools. Felling Axes, ...	3	3	3
Intrenching Tools. Pick Axes, ...	3	3	3
Intrenching Tools. Hand Bills, ...	3	3	3
Intrenching Tools. Spades, ...	6	6	6
Tarred Rope, 2-Inch Coil, ...	1	1	1
Ratline, or Lashing Rope Coils, ...	1	1	1
Spun Yarn, Coils, ...	1	1	1
Grease, Kegs, ...	20	16	16
Horse Harness Rope, Wheel, ...	2	2	2
Horse Harness Rope, Leader, ...	8	4	4
Riding Saddles and Bridles, each spare, ...	2	2	2
Whips, Short, ...	5	3	3
Leggings, Short, ...	5	3	3
Head Stall Halters, with Chain Reins, ...	10	6	6
Iron Hames, Spare, ...	4	3	2
Spare, Nose Bags, Canvas, ...	...	...	...
Spare, Corn Bags for 2 days Corn, ...	...	...	...
Spare, Corn Sacks, ...	...	...	...
Spare, Forage Cord Sets, ...	...	...	...
Spikes, Spring, and Common, each, ...	2	2	2
Priming Irons, Sets.	2	2	2
Park Pickets, ...	60	50	44
Wood Mauls, ...	6	6	6
Lanthorns, Muscovy, ...	4	2	2
Lanthorns, Dark, ...	4	2	2
Candles, ...	36	36	36
Slow Match, cwt.	1	1	1
Tarpaulins for covering Ammunition, ...	1	1	1
Leather Buckets, ...	50	50	50
Wadmiltilts, ...	1	1	1
Hair Cloths, ...	1	1	1
Copper Scales with Beams, ...	1	1	1
Brass Weights, 4 lbs. Pile, ...	1	1	1
For the Smiths. Steel, cwt. Sheer, ...	½	½	½
For the Smiths. Ditto, Blister, ...	½	½	½
For the Smiths. Iron, cwt. Plate, ...	½	½	½
For the Smiths. Iron, cwt. Square, ...	½	½	½
For the Smiths. Iron, cwt. Rod, ...	½	½	½
For the Smiths. Iron, cwt. Round both, ...	½	½	½
For the Smiths. Iron, cwt. Hooping, ...	½	½	½

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TABLE, No. 20, *continued.*

			Field Battery.			
			18-Pounder.	Heavy.	Light.	
For the Smiths.	Coals, Chaldrons, ...		4	4	4	At 6 Sets of Shoes per Horse.
	Horse Shoes, Sets, 3 Sets of Nails each,	...	...	...	...	
	Shoeing Tools, Spare Sets, ...	...	1	1	1	
	Shoeing Tools in a Box, Spare Sets for each Shoeing-Smith,	...	1	1	1	Detail see Forge, Field Battery.
For the Wheeler.	Spare Wheels, Gun, Heavy,	...	...	...	...	
	Spare Wheels, Gun, Light,	...	...	...	...	
	Spare Wheels, Limber, ...	...	...	...	...	
	Spare Wheels, Waggon, Fore,	...	...	...	...	
	Spare Wheels, Waggon, Hind,	...	...	...	...	
For Ditto.	Iron Axles, ...	...	...	...	...	According to the practice of the Carriage Department.
	Shafts complete, ...	...	...	...	...	
	In the rough, Felloes, ...	...	...	...	...	
	In the rough, Spokes, ...	...	...	...	...	
	In the rough, Splinterbars, ...	...	...	...	...	
	In the rough, Shafts, ...	...	...	...	...	
	In the rough, Guides, Fore,	...	...	...	...	
	In the rough, Guides, Hind,	...	...	...	...	
For Ditto.	In the rough, Under Poles, ...	...	...	...	...	
	In the rough, Perches, ...	..	...	...	...	
	Handspikes, Common, short,	...	20	...	...	
	Handspikes, Traversing, ...	...	...	6	6	
	Iron Crows, ...	...	4	...	...	
	Screws of Sorts, ...	...	50	25	25	
	Streaks, ...	...	2000	2000	2000	
For Ditto.	Clasp, 40 Penny, ...	...	500	...	...	
	Clasp, 30 „ ...	...	500	...	...	
	Clasp, 20 „ ...	...	1000	1000	1000	
	Clasp, 10 „ ...	...	3000	2000	1000	
	Clasp, 6 „ ...	...	2000	2000	1000	
	Clout, the largest size chisel pointed, 6 „ ...	...	2000	2000	2000	
	Clout, the largest size chisel pointed, 4 „ ...	...	2000	2000	2000	
	Clout, the largest size chisel pointed, 3 „ ...	...	2000	2000	2000	
	Clout, the largest size chisel pointed, 2 „ ...	...	2000	2000	2000	
	Tacks of Sorts.	...	5000	4000	3000	
Wheelers' Tools	in a Box, spare set, ...	...	1	1	1	Detail, see Wheel Carriage Field Battery.
For the Collar Maker.	Hides, Black, Heavy,	...	3	3	3	
	Hides, Black, Light,	...	3	3	3	
	Hides, White, Horse,	...	3	3	3	
	Basils, dozen Black,	...	9	9	6	
	Basils, dozen Brown,	...	9	9	6	
	Wax, lbs. Black,	...	6	6	6	
	Wax, lbs. Bees,	...	6	6	6	
	Bristles, oz.	...	24	24	18	
	Threads, lbs. Collar, ...	...	18	18	12	
	Threads, lbs. Hemp, ...	...	30	30	24	
	Threads, lbs. White Brown, ...	...	2	2	2	
	Whip Cord, lbs.	...	6	6	6	

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TABLE, No. 20, *continued.*

		Field Battery.			
		18-Pounder.	Heavy.	Light.	
For the Collar-Maker.	Does Hair, cwt.	⁂	⁂	⁂	
	Serge, yards, ...	60	60	60	
	Brushes, sets, Hard, ...	36	36	36	
	Brushes, sets, Soft, ...				
	Brushes, sets, Water, ...				
	Oil, gallons, Sweat, ...	1	1	1	
	Oil, gallons, Neat, ...	30	30	30	
	Oil, gallons, Linseed, ...	6	6	6	
	Turpentine, gallons, ...	1	1	1	Enough to paint once a-year.
	Paint, Lead Colour, cwt.	½	½	½	
	Paint Brushes, large and small, each, ...	6	6	6	
	Straps for Side Arms, ...	18	18	18	
	Block Iron 2-Inch, ...	6	6	6	
	Block Iron 1¾	9	9	9	
	Buckles of 1½	9	9	9	
	Sorts, dozen 1	9	9	9	
	Sorts, dozen ¾	9	9	9	
	Camp Equipage, in the proportion as heretofore,	...	...	...	To be issued when demanded.
For the Collar-Maker.	Collar-Makers' Tools in a Box spare set,	1	1	1	Detail, see Store Waggon, Field Battery.
	Blankets, ...	...	...	...	One for each man, military and civil, issued when taking the field. One fourth spare in reserve, also a blanket for each horse.
	Canteens, ...	...	...	...	
	Haversacks, ...	...	...	...	

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The following was a proportion of Farriers' Medicines formed by Veterinary Surgeon O'Connor, by order of Major-General Howorth, on the Peninsula Service, as sufficient to accompany a Brigade of 120 Horses in the field for two months. Similar proportions were placed in boxes with the several depôts, from whence the demands made by the Brigades monthly were supplied.

To save space, the actual list of Medicines and Stores now sent into the Field by Mr. Veterinary Surgeon Stockley, for six months supply of 200 horses, is incorporated with Mr. O'Connor's list. In furnishing this list, Mr. Stockley has added a remark to which his long experience gives great importance; that a more complete and systematic mode of training Farriers is one of the requirements of the service at the present day.—*Ed.*

(Remark by Mr. Stockley.)

The numerous sub-divisions of the mounted branch of the Royal Artillery, subjects it most injuriously to persons very incompetent to the management of Horses even in health, but more especially unequal to their treatment in disease. The Officers require instruction in the general principles of Anatomy, Physiology, and Pathology, by which we learn to avert or correct the evils attendant on the removal of the Horse from a state of Nature to that of Art; and the Farriers, who are generally deficient even in general education, require similar instruction, with the addition of probationary practice under the Veterinary Surgeon, at the Royal Artillery Horse Infirmary.

	Stockley. 1854.	*O'Connor.* 1812.		*Stockley.* 1854.	*O'Connor.* 1812.
Alum, ...	lbs. 1	lbs. 8	Nitre, Sal, ...	lbs. 6	lbs. 1
Balling Gun, ...	1		Do. Sweet Spirits of...	... 2	
Bandages, Flannel, ...	20		Oil, Black, ...	... 1	
Blinds, Pairs, ...	1		Do. Common, ...	... 4	... 2
Book of Directions, ...	1		Ointment, Alum, ...	... 1	
Camphor, ...	lbs. ½		Do. Blistering, ...		... 2
Cloths, Flannel, ...	12		Do. Turpentine, ...	... 2	
Do. Linen, ...	12		Do. Wound. ...		
Clyster pipe & 6 bladders,			Opium, Tinct., ...	... 2	
Fleams, sets, ...	1		Paper, wrapping, quires,	2	
Hobbles, ...	4		Powder, Antipurgation,	lbs. 1	
Horn, Drench, ...	1		Do. Astringent, ...	... 2	
Ladle, Iron, ...	1		Do. Vermifuge, ...	... ½	
Lancet, ...	1		Rope, ...	1	
Lead, Sugar of	lbs. 1	... 1	Salt, Common, ...	lbs. 3	... 4
Liniment, Turpentine, ...	... 4		Scales & Weight, Set,	1	
Liquid, Blistering, ...	... 4		Silver, Nitrate of ...	drms. 2	
Mass, Alterative,... ...	... 4		Spatula, Iron, ...	1	
Do. Cathartic, ...	... 7	... 1	Sulphur, ...	lbs. 4	
Do. Diuretic, ...	... 7		Syringe, Pewter, ...	1	
Do. Febrifuge.	... 7	... 2	Tape, Pieces, ...	2	
Do. Sedative, ...	... 3	... 1	Tar, ...	lbs. 7	
Do. Tonic, ...	... 2		Tow, ...	... 4	... 4
Meal, Linseed, ...	... 6		Turpentine, Spirits of ...	... 4	
Mortar and Pestle, ...	1		Vitriol Blue, ...	... ½	... 2
Myrrh, Tinct., ...	lbs. 1		Do. White, ...	... 1	

In the arrangement, proposed by Mr. O'Connor, the box containing the Medicines was kept in the Store Waggon, whence a smaller proportion was issued to the Farrier, and kept in a small box in the Limber of the Forge-Waggon.

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The proportion for 180 horses, 1½ the foregoing, *(i.e. Mr. O'Connor's scale, Ed.)*, would meet the wants of a 9 or 12-Pr. Field Battery; or a box properly filled with canisters, &c., for the above proportion, placed in the Store Waggon, and a smaller box, fitted in like manner for a half proportion carried with the Farrier on the Forge Limber-Box, would be more convenient.

N.B.—It is to be observed, that there may be in the foregoing detail of field equipments some trifling omission of spare articles, as the chief object has been to form a general principle of equipment. And where even the nature of the articles are defined, the proportion and quantity of spare and general stores, must be regulated according to the circumstance of the country in which the intended operations are to be conducted.

TABLE, No. 21.

Proposed distribution of Artillery, to place on an efficient Establishment for Active Service, a Corps similar to that with the late Army of Occupation in France, in 1818.

1. The corps is supposed to consist of 24,000 Infantry, 3,000 Cavalry, the Infantry being formed in three, and the Cavalry in one division.

2. With this corps it is proposed to have ten Batteries, all of 9-Pounders, viz.:—

3 Batteries of Horse Artillery.
7 Batteries of Field Artillery.

Viz.	*Guns.*
Cavalry Division,	6
1st. Infantry do	12
2nd. ditto ditto,	12
3rd. ditto ditto,	12
Reserve,	18
Total pieces	60

3 Each division of Infantry to have two Batteries of Field Artillery, and the division of Cavalry one Battery of Horse Artillery.

The reserve to consist of 2 Batteries of Horse Artillery, 1 ditto of Field Artillery.

AMMUNITION.

	Rounds.
Each 9-Pounder	163
Each 24-do. Howzr	144

4. These Batteries to be equipped according to the establishment lately drawn out: they will therefore move with ammunition as per margin.

	Rounds.
Each 9-Pounder	257
Each 24-do. Howzr	201

5. The reserve of gun ammunition to be conveyed in 60 Limber Waggons, being in the proportion of one waggon for each piece of Ordnance with the Corps. This reserve will complete the ammunition in the field, as per margin.

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Reserve Ammunition.	
Limber Waggons with Cavalry,.....	3
Do. 1st. Division of Infantry,.....	6
Do. 2d. do. do.....	6
Do. 3d. do. do.....	6
Do. with general reserve,..... ..	39
	60

6. A portion of the reserve gun ammunition, consisting of a waggon for every two pieces of Ordnance, to accompany the divisions of Cavalry and Infantry, and the remaining gun ammunition to be with the general reserve.

[*W.*] There being enough for one battle with the batteries, there ought to be enough for a second with the army in the park or reserves, and enough for a third in a field depôt, which would be fixed according to the disposition of the Commander-in-Chief.

[*C.*] The Committee here beg leave to observe, that according to His Grace's allotment of ammunition, an increase of about 30 ammunition waggons will be required for the moveable equipments.

7. The Artillery, with divisions, will therefore have, agreeable to the arrangement No. 6,

210 Rounds per Gun.
174 ditto. per Howitzer.

But as the Cavalry reserve of gun ammunition consists only of three waggons, it is proposed that they should all contain 9-pounder ammunition, which would increase the rounds per Gun a little, and the Howitzer would have 144 rounds only.

With Cavalry Divn.	4
1 Division Infantry,	12
2 Ditto ditto,	12
3 Ditto ditto,	12
In general reserve,	60
Total,	100

8. The reserve of small arm ammunition to be conveyed in 100 limber waggons, distributed as per margin, each waggon containing 20,000 musquet ball cartridges.

[*W.*] This would do with 1,200,000 rounds in depôt.

[*C.*] The depôt would add 50 rounds per man to the 140 rounds already allotted, making the proportion as follows:—

Carried by the soldiers, ...	60 rounds.
Reserves of ball cartridges, ...	80 ditto.
In depôt, ...	50 ditto.
Total rounds per man, .	190

9. The reserve gun and small arm ammunition attached to the Cavalry to be formed into a division commanded by a Lieutenant, as follows:—

	3 Limber Waggons of Gun Ammunition.
	4 Ditto ditto of Cavalry small arm do.
	1 Forge.
	1 Store Waggon.
Total,	9 as per detail of Equipment.

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10. The above mentioned gun and small arm ammunition attached to a division of Infantry to be formed into reserves, each commanded by a Captain, as follows: —

6 Limber Waggons of Gun Ammunition.
12 Ditto Ditto of Small Arm Ammunnition.
1 Forge.
1 Store Waggon.
1 Spare Howitzer Carriage.

Total, 21 as per detail of Equipment.

11. The sixty small arm ammunition limber waggons in general reserve, to be formed into divisions of 20 waggons, each commanded by a Captain, as follows:—

20 Small Arm Ammunition Limber Waggons..
1 Forge.
1 Store Waggon.
1 Ditto with Stores for general distribution.

Total, 23 as per detail of Equipment.

12. The thirty-nine gun ammunition limber waggons in general reserve, (or say 40 to make an equal number) to be in like manner formed into divisions of 20 waggons, with the same additional carriages, making 23 in all per division, as expressed in No. 11.

13. *Distribution of Ordnance and Carriages.*

		Batteries.								Reserves.					
		9-Pounder.	24-Pr. Howitzer.	Limber Waggon.	Forge.	Spare 9-Pr. Carriage.	Store Waggons.	Store Cart.	Total.	Limber Waggon, G.A.	Limber Waggon Small Arm Ammunition.	Forge.	Spare Hzr. and Cs.	Store Waggon.	Total.
Division of 1 Battery, Horse Artillery,		5	1	9	1	1	1	1	19	...	...	...	...	...	...
Cavalry, Ammunition Reserve,		...	...	...	...	...	...	...	...	3	4	1	...	1	9
1st Division Infantry.	One Field Battery,	5	1	9	1	1	1	1	19	...	...	...	...	...	...
	One ditto,	5	1	9	1	1	1	1	19	...	...	...	...	...	...
	Ammunition Reserve,	...	...	...	...	...	...	...	...	6	12	1	1	1	21
2nd Ditto.	One Field Battery,	5	1	9	1	1	1	1	19	...	...	...	...	...	...
	One ditto	5	1	9	1	1	1	1	19	...	...	...	...	...	...
	Ammunition Reserve,	...	...	...	...	...	...	...	...	6	12	1	1	1	21
3rd Ditto,	One Field Battery,	5	1	9	1	1	1	1	19	...	...	...	...	...	...
	One ditto,	5	1	9	1	1	1	1	19	...	...	...	...	...	...
	Ammunition Reserve,	...	...	...	...	...	...	...	...	6	12	1	1	1	21
Reserve,	1st Battery Horse Artillery	5	1	9	1	1	1	1	19	...	...	...	...	...	...
	One do. do. do.,	5	1	9	1	1	1	1	19	...	...	...	...	...	...
	One Field Battery,	5	1	9	1	1	1	1	19	...	...	...	...	...	...
	1st Division Gun Ammunition,	...	...	...	...	...	...	...	...	20	...	1	...	2	23
	2nd do. do. do ...	...	...	...	...	...	...	...	...	20	...	1	...	2	23
	1st Divn. Small Arm Ammunition...	...	...	...	...	...	...	...	...	...	20	1	...	2	23
	2nd do. do. do do...	...	...	...	...	...	...	...	...	...	20	1	...	2	23
	3rd do. do. do. do...	...	...	...	...	...	...	...	...	...	20	1	...	2	23
	Tatal,	50	10	90	10	10	10	10	190	61	100	9	3	14	187

See No. 12.

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14. According to the foregoing arrangement, the small arm will be distributed as follows:—

For Infantry.

In possession of the Soldiers, ...	60	Rounds per man.
36 Waggons with Divisional Reserves, ...	30	"
60 Ditto in general Reserve, ...	50	"
Total, ...	140	

For Cavalry.

In possession of the Soldiers, ...	30	Rounds per man.
4 Waggons with Divisional Reserve, ...	30	"
Total, ...	60	

15. A Troop or Company of Artillery to be attached to each Battery, and half of a Troop or Company to each reserve of gun and small arm ammunition.

3 Batteries of Horse Artillery, ...	3 Troops.	
7 Batteries of Field Artillery, ...		7 Companies.
1 Reserve Cavalry Division, ...		
1 Infantry Do., ...	9 Reserves, ½	4
2 General Reserve Gun Ammunition, ...		
3 Do. Small Arm Ammunition, ...		
Total, ...	3½ Troops.	11 Companies.

The half Troop of Horse Artillery to be considered as a reserve of men to keep up the Horse Artillery Battery. It should be dismounted, and in strength should consist of half the Non-Commissioned Officers and men of a Troop, on the full establishment for active service. This half Troop should take the duty of the Cavalry Ammunition Reserve, and the overplus officers and men be posted to a division of general reserve gun ammunition till otherwise wanted.

16. Three Troops mounted, and half a Troop dismounted, according to the establishment already detailed, and eleven Companies will be quite sufficient for the duties in the field; provided each Company has 12 Non-Commissioned Officers, and 90 Gunners.

The Royal Artillery Drivers to be of course, in conformity to the numbers required for the different equipments.

Infantry.

1st. Division.		2d. Division.		3d. Division.	
F. Battery, 9-Pr.	F. Battery, 9-Pr.	F. Battery, 9-Pr.	F. Battery, 9-Pr.	F. Battery, 9-Pr.	F. Battery. 9-Pr.
Reserve.		Reserve.		Reserve.	
6 Gun Ammu. Waggons.		6 Gun Ammu. Waggons.		6 Gun Ammu. Waggons.	
12 Small Arm Do. Do.		12 Small Arm Do. Do.		12 Small Arm Do. Do.	
3 Forge Store Waggons,		3 Forge Store Waggons,		3 Forge Store Waggons,	
— &c.		— &c.		— &c.	
21 Total Carriages.		21 Total Carriages.		21 Total Carriages.	

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Reserve Artillery and Ammunition.

Horse Artillery Battery, 9-Pr.		Field Battery, 9-Pr.	Horse Artillery Battery, 9-Pr.	
8 Division S.A. Ammunition.	2 Division S.A. Ammunition.	1 Division S.A. Ammunition.	2 Division Gun Ammunition.	1 Division Gun Ammunition.
20 Waggons.	20 Waggons.	20 Waggons.	20 Waggons.	20 Waggons.
3 Forge, &c.	3 Forge, &c.	3 Forge, &c.	3 Forge, &c.	3 Forge, &c.
23 Carriages.	23 Carriages.	23 Carriages.	23 Carriages.	23 Carriages.

19. Supplying the Battery of Horse Artillery with the Cavalry, and one Battery with each division of Infantry with 6-Prs., the Ammunition would be as follows:—

Rounds per 9-Pounder, ...	257
Ditto per 6-Pounder, ...	371
Ditto per 24-Pounder Howitzer, ...	204

Difference between 9-Pr. and Limber 6-Pr. Troops.....	34
Difference betweeen three 9-Prs., and three Limber 6-Pr. Batteries,	63
Total,...	97

By this arrangement of twenty 6-Prs., the army would have 2280 rounds of gun ammunition, more than if the equipment was all 9-Prs., and at the same time would have 97 horses less.

17. *Abstract.*

	Troops.	Batteries. No. of Batteries.	Guns.	Howitzers.	Total.	No. of Reserve Gun Ammunition Waggons.	No. of Small Arm Ammunition Waggons.	Horses.
Cavalry Division, ...	3000	1	5	1	6	8	4	264
1t. Division Infantry, ...	8000	2	1	2	12	6	12	439
2nd. Ditto Ditto, ...	8000	2	1	2	12	6	12	439
3rd. Ditto Ditto, ...	8000	2	1	2	12	6	12	439
Reserve Artillery, ...	...	3	1	3	18	40	60	1204
Total, ...	...	10	50	10	60	61	100	2785
In the event of an 18-Pr. Battery being required, add	...	...	3	1	4	...	...	198
								2983

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Proof of the Horses.

3	Batteries of Horse Artillery, at 220,	660
7	Ditto of Field Artillery, at 164,	1148
1	Cavalry Reserve of Ammunition, at 44,	44
3	Infantry Division Reserve of Do., at 111,	333
2	Division General Reserve Gun Do. at 120,	240
3	Ditto ditto Small Arm ditto, at 120,	360
	Total,	2785

18. *Disposition.*

Cavalry Division.

Horse Artillery Battery, 9-Pounder.

Reserve.

3 Gun Ammunition Waggons.
4 Small Arm Ditto Ditto,
2 Forge and Store Waggons.

9 Carriages.

32.-Pr. BATTERIES.

(Additional Note by the Editor to page 191.*)*

Since the foregoing sheet was printed, the actual equipment of a Battery of 32-Pr. Iron Guns for Field Service in the East, has been determined upon ; and the following information has, been kindly communicated by Capt. H. Clerk, with permission of the Inspector Royal Carriage Department.

32-*Pr. Battery, with two Companies of Artillery under a Field Officer.*

Carriages.		Weight of one.		Probable Draught Horses.
		Unloaded.	Loaded.	
6	Gun Carriages, 32-Pr. of 42 Cwt.	30 Cwt.	72 Cwt	72
12	Store Limber Waggons for Ammunition, ...	18½ ...	47* ...	96
2	Flanders Waggons for Stores, ...	17 ...	36 ...	12
1	Forge Waggon,...	17 ...	22 ...	6
1	Store Cart, ...	19¼ ...		2
1	Spare Gun Carriage, ...	30 ...	52¼ ...	8
23				196

* Six of these waggons carry a spare wheel ; making their weight about 2 cwt. greater.

Each Store Limber Waggon to carry 32 solid shot, 16 Shrapnel, 16 common shells, 8 common case—total 72 rounds, with the same number of 6lb. charges. The Guns are mounted on the 18-Pr. Travelling Carriage, with the New Pattern 24-Pr. Axletree, and Wheel. Poles for bullock draft are supplied to them, as well as shafts, and a couple of drag ropes and a prolonge are carried on the gun limber.

The trail box carries the following stores:—

1 Tube box.	Spikes, spring or common.	Punches for vents.
1 Box of Tubes.	2 Lanyards for friction tubes.	1 Set of priming irons.
1 Thumbstall.	1 Leather cylinder.	1 Knife.
3 Portfires.	2 Linch-pins and washers.	1 Pair of Scissors.
1 Portfire clipper.	1 Skein of Marline.	1 File.
1 Portfire stick on box or carriage.	1 Skein of Hambro' line. Slowmatch.	1 Rammer head, coating and crown for spunge.

The Spare Gun Carriage carries 2 Gun and 2 Gun Limber Wheels; 2 Gun and 1 Limber Axletree; 1 Pole; 2 Shafts; and 1 Elevating Screw with nut.

The Flanders Waggons carry 2 Shafts, 2 Splinter-bars, 1 Axletree and fore Waggon Wheel underneath: a small store box in front, containing 24 lbs of Grease, 10 sets Horse Shoes and Nails; spare India Rubber Springs and Bolts, &c. &c.

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Ammunition Reserve, Cavalry Division.

Number.		Royal Artillery.				Royal Artillery Drivers.					Horses.			
		Officers.	N. C. Officers & Drummers.	Gunners.	Total.	Officers.	N. C. Officers & Trumpeters.	Artificers.	Drivers.	Total.	Draft.	Riding.	Baggage.	Total.
4	Limber Waggons, Small Arm Ammunition, 30 Rounds per man,													
3	Ditto, Gun Ammunition,													
1	Forge Waggon,													
1	Store Waggon.	...	...	...	...	...	...	...	18	18	36	...	...	36
9	Carriages.													
	ROYAL ARTILLERY.													
1	Lieutenant, ...	1	...	...	1	...	...	...	1	1	...	...	1	1
2	Non-Commissioned Officers, ...	...	2	...	2	...	..	...	...	...	...	...	...	...
15	Gunners, ...	...	...	15	15	...	...	...	...	...	...	...	...	...
18	Total Artillery, ...	1	2	15	18									
	Royal Artillery Drivers, ...	1	2	15	18	...	8	4	23	30	40	3	1	44
12	Limber Waggons Small Arm Ammunition,													
6	Ditto Gun Ammunition,													
1	Forge,													
1	Store Waggon,													
1	Howitzer Carriage,	...	...	...	...	...	...	...	42	42	84	...	...	84
21	Carriages.													
	ROYAL ARTILLERY.													
1	Captain, ...	1	...	...	1	...	...	...	1	1	...	1	1	2
2	Subalterns, ...	2	...	...	2	...	...	...	2	2	...	2	2	4
1	Surgeon, (1 Horse for Medicines,) ...	1	...	...	1	...	...	...	1	1	...	1	2	3
1	Serjeant, ...	...	1	...	1	...	...	...	...	...	...	...	...	...
2	Corporals, ...	...	2	...	2	...	...	...	...	...	...	...	...	...
3	Bombardiers, ...	...	3	...	3	...	...	...	...	...	...	...	...	...
1	Drummer, ...	...	1	...	1	...	...	...	...	...	...	...	...	...
40	Gunners, ...	...	...	40	40	...	...	...	...	...	...	...	...	...
51		4	7	40	51									
	Royal Artillery Drivers, ...	4	7	40	51	...	6	7	56	69	94	12	5	111
20	Limber Waggons, Gun Arm Ammunition,													
1	Forge,													
1	Store Waggon,													
1	Store Waggon with Stores for gen. Distribution	...	...	...	...	...	...	...	46	46	92	...	...	92
23	Carriages.													
	ROYAL ARTILLERY.													
1	Captain, ...	1	...	...	1	...	...	...	1	1	...	1	1	2
2	Subalterns, ...	2	...	...	2	...	...	...	2	2	...	2	2	4
1	Surgeon, (1 Horse for Medicines,) ...	1	...	...	1	...	...	...	1	1	...	1	2	3
1	Serjeant, ...	...	1	...	1	...	...	...	...	...	...	...	...	...
2	Corporals, ...	...	2	...	2	...	...	...	...	...	...	...	...	...
3	Bombardiers, ...	...	3	...	3	...	...	...	...	...	...	...	...	...
1	Drummer, ...	...	1	...	1	...	...	...	...	...	...	...	...	...
40	Gunners, ...	...	...	40	40	...	...	...	...	...	...	...	...	...
51		4	7	40	51									
	Royal Artillery Drivers, ...	4	7	40	51	...	6	7	61	74	103	12	5	120

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Ordnance Commissariat for a Corps of the before mentioned Strength.

STORE BRANCH.	Chief or principal Commissary.	Commissary.	Assistant Commissary.	Clerk of Stores, Deputy-Assistant Commissary.	Conductors.	Total.
For the whole command, at or near Head-Quarters, ...	1	...	2	3	3	9
For the point of Debarkation, ...	...	1	1	3	3	8
For two Depots, fixed Stations, ...	...	...	2	2	4	8
Three Divisional Ammunition Reserve, ...	...	...	...	3	3	6
One Ditto Cavalry Ditto Ditto, ...	...	...	...	...	1	1
Two Reserve General Ammunition, ...	...	...	...	5	5	10
Total, ...	1	1	5	16	19	42

PAY BRANCH.	Pay-Masters.	Assistant Pay Masters.	Clerks.	Total.
For the whole command at or near Head-Quarters, ...	1	...	5	6
For the Point of Debarkation, ...	...	1	2	3
For the Payment of Batteries and Reserves considerably detached, ...	...	1	2	3
Total, ...	1	2	9	12

Remarks on the Formation of Ordnance Commissaries.

The Sub-Committee propose, that the Clerks of Stores should be styled Deputy-Assistant Commissaries, or the Paymasters, to place this class, whose duties are important in the Artillery service, on a par with similar appointments in the General Commissariat of the army; inconvenience and delay having been experienced in detached situations, from the Clerks of Stores being considered on a footing with the inferior class of Clerks attached to the several departments of the army.

The Sub-Committee are of opinion, that the conductors with the ammunition reserves would be better constituted by being Non-Commissioned Officers taken from the Companies, with a small addition to their pay while so employed; and those at the depôt, or employed in the offices of the Commissaries, to be composed of pensioned Non-Commissioned Officers of intelligence, with competent pay, to

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whom such an appointment would be an object: for their duties require a knowledge of stores, and are in many cases laborious, which the young lads that have hitherto been appointed as conductors have in general proved entirely unequal to.*

TABLE, No. 22.

Observations with regard to the Quality, Mode of Packing, and Conveyance of Small Arm Ammunition.

Quality.

1. The variety of small arms made use of in the British army is a matter requiring particular consideration, as nothing can be more embarrassing on service than the complication occasioned by a great many natures of ammunition. This was fully exemplified in the Peninsular war, when no less than nine different kinds were carried in the field, viz. :—

Musket.

Rifle,	...	...	...	22 to the lb. 20 to the lb.		
Carbine,	...	...	...	5½ Drachms,	Heavy Cavalry.	
Pistol,	...	...	...	3½ Ditto,	Musquet Bore.	
Carbine,	...	...	...	4 Ditto,	German Hussars,	Carbine Bore.
Pistol,	...	...	...	3 Ditto,		Common Pistol Bore
Carbine,	...	...	...	3 Ditto,	Light Dragoons.	
Pistol,	...	...	...	3 Ditto,	Carbine Bore.	

In which it is to be observed, there are two kinds of Rifle, and no less than six of Cavalry ammunition. Both the species of Rifle ammunition, it is true, are for the same arm; but the different Rifle Corps did not fully accord as to their use, some preferring the cartridges of 20 to the lb., and of others those of 22 to the lb., covered with fustian. It would therefore be a desirable thing to consult the Officers most conversant with Rifle duties, to ascertain the kind of ammunition they consider best calculated for the service in general, and also that some experiment should be made to prove the same, in order that the Rifle ammunition, if possible, may be reduced to one nature.

With regard to Cavalry ammunition, the Sub-Committee cannot help thinking it might be reduced to two natures of charge for the whole Cavalry service, viz., *Carbine* and *Pistol*; and it appears to them great convenience would attend the Cavalry small arms being all of Carbine Bore, which would admit of the Rifle cartridge being occasionally used, when no Cavalry ammunition was at hand.

* The above recommendation has been acted on in the arrangement made for the war in the Crimea.

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[*W.*] This is difficult, from the occasional use of the Rifle as a musquet.

When used as a musquet, it is put in with a common cartridge; but even in this case, it ought to be the largest ball which the pieces could receive.

When used as a Rifle, the ball is larger, and is forced in the piece.

I should doubt the use of the fustian, it must be liable to leave fire in the barrel.

[*C.*] The Committee have strongly recommended experiments, both with Rifles and small arms generally, as they consider the subject to be very imperfectly understood, and to require more simplicity in its general arrangement.

Some progress has been made within the last few years towards a simplification of our Small Arm Ammunition, and it is now intended, at as early a period as possible, to carry out the principle of entire uniformity of bore. The Enfield Rifle Musquet, Pattern of 1853, diameter of bore 0·577, is the standard to be adopted At present, however, there are as many as twelve varieties of Small Arm Ammunition made up in the Royal Arsenal, as both the old and the new descriptions are required.—*Ed.*

	Bore.	Charge.	Ball.	
The smooth bore Musquet of 1842, ...	·753	4½ dr.	490 gr.	*Sph.*
The same, rifled, with heavy Minie ball, as used by the Navy and Marines, ...	·753	3 ...	817 ...	*Min.*
The Regulation rifle Musquet. 1851, ...	·702	2½ ...	670 ...	*Min.*
The Enfield rifle Musquet, 1853, ...	·577	2½ ...	530 ...	*End.*
Brunswick rifle, 12½ to lb., ...	·704	2½ ...	560 ...	*Belted.*
The Victoria Carbine, 1845, ...	·733	2½ ...	490 ...	*Sph.*
Short Musquet for Sappers, 1845, ...	·733	3½ ...	490 ...	*Sph.*
Do. for Serjeants of the Line,... ...	·733	4½ ...	490 ...	*Sph.*
The Artillery Carbine, 1853, ...	·577	2 ...	530 ...	*End.*
The Cavalry Pistol, 1845.	·733	2½ ...	490 ...	*Sph.*
Pistol, carbine bore, 20 to lb., ...	·653	2½ ...	350 ...	*Sph.*
Pistol, Sea Service, 34 to lb., ...	·567	2 ...	206 ...	*Sph.*

Min. Minie bullet, with cup. *End.* Enfield—Pritchett bullet without cup *Sph* Round ball.

2. It has frequently been a subject of complaint, that the established charges of small arms are too great; and many Officers of experience have given it as an opinion, that the expected re-action of the arm in firing occasions want of precision; indeed, from the dread of this, the soldiers, in loading, are in the habit of shaking out part of their powder, which must cause great uncertainty of effect. This being a matter highly deserving consideration, the Sub-Committee think, if experiments on the subject were carried on, it would probably be found, that by a reduction of one-sixth, or even one-fourth of the charge, the effect would be equally good; the more so, as the strength of powder is now greatly increased. It is further to be added, that by this would be obtained the advantage of a considerable economy of powder.

Subsequent experiments have fully sustained this opinion of the Committee. On the introduction of the percussion lock, the charge of the Musquet was reduced from 6 drams to 4½ drams: and this has been further reduced in the Minie Arms, as is shown above —*Ed.*

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Mode of Packing.

3. The mode of packing small arm ammunition in half and quarter barrels, as has hitherto been the practice on service, is highly objectionable, on account of the ammunition not stowing well in the circular form of the barrel; and it was attended with great inconvenience during the late war, but particularly in the Peninsula, both in mule carriage, and in conveying the ammunition in musquet ball cartridge carts; for which the former, which was the principal means of transport, the barrels were very inconvenient to handle in loading and unloading the mules, being liable to constant falls, by which the ammunition was shaken and damaged, the hoops broke, and the barrels injured; so as to render it necessary to have a cooper with the smallest detachment of mules. In addition to this, the loads, but particularly with quarter barrels, were so very unsteady on the mules, as to retard them frequently on the march.

With respect to the conveyance in ball cartridge carts, the ammunition was greatly shaken and injured, in consequence of not being compactly stowed in the barrels, which from hoops, &c., breaking, required the most unremitted attention of a cooper to keep them in repair; and it was further necessary to have coopers at all the fixed depôts, for the purpose of opening and closing ammunition, for inspection previous to issue.

The objections with regard to packing small arm ammunition in barrels, having been submitted to the Master-General and Board, it was finally determined to substitute boxes for this purpose, as they would require little or no repair, be more convenient for stowage and conveyance, afford great facility in inspecting the ammunition, and at the same time, rendered the employment of coopers no longer necessary.

This arrangement has not been acted upon yet upon service, nor indeed does it appear that the description of box has been fully considered; for the Sub-Committee cannot help thinking the one constructed in the Laboratory is not sufficiently simple: they wish therefore to recommend the adoption of a common deal box, firmly put together, of a size to contain 1000 musquet ball cartridges; and they have accordingly had one prepared, which they consider would perfectly answer the purpose required.

[*W.*] It should be strong enough to be caulked.

[*C.*] In the opinion of Artificers, caulking is not desirable. But the obvious intention and wish being to protect the ammunition from wet, it is believed that the present box, as now altered, will fully answer that purpose.

Cartridges have been prepared in paper prepared with boiled oil, which have no unpleasant taste or smell, do not foul the barrel, and have been fired without inconvenience, after an immersion of six hours in water.

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4. The Sub-Committee cannot conclude their observations on this branch of the subject, without mentioning the advantages they expect to be derived from the cartridges being packed with oil-paper, as is now doing for experiment in the Royal Laboratory.

Conveyance of Small Arm Ammunition.

5. The usual mode of conveying small arm ammunition in the British service has hitherto been the musquet ball cart, holding 12,000 rounds, and drawn by two horses. During the Waterloo campaign, however, only 10,000 rounds were carried in the cart, as that quantity was deemed a sufficient load; but this, in common slow movements, even was found too much for a pair of horses: far less could they be expected, therefore, to move at an accelerated rate, when such was necessary.

In the Peninsula, where it was an object to take forward as great a quantity of ammunition as possible, the cart carried the 12,000 rounds; but to insure its getting on, there was a necessity for its being drawn by four horses, and they would have been required in France, on account of the deepness of the cross roads, had the cart been loaded to its full extent.

From the above, therefore, it appears that the present ball cartridge cart with the reduced load, is too much for a pair, and that it will contain too little ammunition for four horses. To remedy this inconvenience, therefore, the Sub-Committee are of opinion, that four-wheeled carriages for small arm ammunition would be far preferable to carts, and would afford the power of a better application of physical force for their movement.

Ammunition Limber Waggons have been fitted up in the Carriage Department in two different ways, for the conveyance of 12,000 musquet ball cartridges each, which the Sub-Committee beg to submit; and by the adoption of either of them, the great advantage will be obtained of one general ammunition limber waggon being used for the whole service.

In one mode of fitting, the caisson or coffer on the body contains 12,000, and that on the limber 8000 cartridges, packed in the deal boxes, 1000 each, before mentioned.

And in the other mode, the same proportions are carried in three boxes on the body, and two on the limber, the ammunition being packed in tin cases to contain 500 or 1000 cartridges each, covered with painted canvas; the ammunition is thus perfectly secure against weather, and is packed in the least possible compass. But on the fullest consideration of the whole subject, the Sub-Committee beg to recommend the former mode, as simpler for the general arrangement of small arm ammunition.

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6. The Sub-Committee have to observe, that although in their arrangement for field equipment, the small arm ammunition limber waggons are proposed for 20,000 rounds, to move with four horses each, it is not without having adverted to the increased weight of the carriage, thus loaded beyond other ammunition carriages, which would render a diminution of ammunition necessary in the event of a difficult country: at the same time it has been deemed advisable that the waggon should be able to contain 20,000, in case the scene of operations admitted a facility of movement.

There would, as circumstances varied, therefore, be the power of regulating the movement of small arm ammunition as follows:—In a good country and summer season, the waggons might move with 20,000 rounds, drawn by four horses; but in the event of a different country, on a procrastinated campaign, the same load would require an additional pair of horses; and under every circumstance, the service might be continued with four horses, by diminishing the load of the waggon to 16,000, which its construction would admit of being done without danger, or injuring the ammunition.

A considerable advantage would be obtained also by the waggon being fitted for 20,000 rounds, as it would afford the means of bringing forward the greatest possible quantity from the depôts, and also of moving forward a greater proportion to points of assembly preparatory to battle, or for supply of advanced reserves, which in many instances would admit of waggons being sooner sent to the rear for more ammunition: besides, in the adoption of the general limber waggon, there would be little or no difference of weight in the waggon itself, whether it was prepared to carry 16,000 or 20,000 cartridges.

Note.—In the Expedition to Turkey, 1854, the Small Arm Ammunition was conveyed in Limber Waggons, each carrying 40 boxes of 500 rounds—total 20,000 rounds, with Camp Equipage, and the usual Intrenching Tools. 36 Waggons, 2 Store Carts, 2 Forge Waggons, and 2 Store Limber Waggons, formed one Brigade, under a Captain of Artillery, with 190 men, and 198 Horses. These waggons, loaded, were as heavy as a 9-Pr. Gun, although four horses only were allotted to them; and from defective balance, bore most severely on the shaft horse; their use in the field was soon abandoned, and the boxes were transferred to pack saddles, to be carried by horses of the country. The loading the animals, and the lashing of the boxes securely, is said to have been always attended with much trouble; to avoid which, a species of strong saddle bag, exactly containing the box, has been suggested, but is not at present introduced.—*Ed.*

7. It may be argued in favour of two-wheeled carriages, that they would be more easy to conduct up great steeps, or to extricate from difficulties; but, reverting to the experience in Portugal, it may be considered as quite conclusive, that a four-wheeled carriage like our ammunition limber waggon, fairly horsed, can be conducted over every species of country where there is any thing like a carriage road; and on the other hand, the carriages with four wheels would possess the following important advantages over those with two.

There would be less wear and tear of horses than with the carts,

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where all work in shafts, and consequently fewer spare horses would be required with waggon reserves.

Carts would require to have all large, or what are termed wheel-horses, whereas a mixed description of horses would be available for waggons, to be distributed for wheel and leading, as is practised with Batteries of Artillery.

The movement of ammunition reserves on waggons would be more compact than in carts, and form a shorter column in the line of march.

Should it be required to detach ammunition with great expedition from a waggon reserve towards any given point, it might be done by taking the leading horses from half the waggons, and advancing the other half rapidly with six horses, or by unlimbering, and sending the limbers alone with four horses. But this is an advantage that a reserve of carts would not admit of, for want of leading horses.

In case of retreat, and being pressed by an enemy, should the horses be hard worked, and the road very bad, considerable casualty would naturally be the consequence, which would occasion many carts being lost or destroyed; for it would be impossible for a cart to proceed with one horse, though a waggon could do so with three; that is to say, if a reserve of 12 waggons was diminished to 36 draft horses, it still could continue to move without diminution of carriages, whereas a reserve of 24 carts under similar circumstances would be obliged to abandon six carts besides. In the line of march, if a horse dropped down in a waggon, it could easily be extricated, and the waggon move on; whilst the same thing occurring with a cart, if a spare horse was not at hand, the movement of the column would either be interrupted, or the cart thrown out of the road.

8. To conclude, the then Sub-Committee recommend that the principal small arm ammunition reserve of an army should always have with it a proportion of implements for making up ammunition, and also materials, if they can be conveyed.

(Signed) WILLIAM MILLAR,
Colonel, Royal Artillery.
" WILLIAM ROBE,
Colonel, Royal Artillery.
" AUGUSTUS FRAZER,
Lieut.-Colonel, Royal Horse Artillery.
" ALEXANDER DICKSON,
Captain, R.H. Artillery, and Lieut.-Colonel.

Woolwich, April 10th, 1821.

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Detail of a Battering Train of 100 *Pieces of Heavy Ordnance.*

The 24-Pounders, at 1000 Rounds per Gun.
The 12-Pounders, at 1200 Ditto, Ditto.
} Exclusive of Case and Spherical.

The 10-Inch and 8-Inch Shells, at 600 Rounds per Mortar and Howitzer.
The $5\frac{1}{2}$-Inch and $4\frac{2}{5}$-Inch Shells, at 200 Rounds per Mortar.
} Exclusive of Case and Carcasses.

ORDNANCE AND IMPLEMENTS.	Guns.		Howitzers		Mortars.				
	24-Pounder.	12-Pounder.	10-Inch.	8-Inch.	10-Inch.	8-Inch.	$5\frac{1}{2}$-Inch.	$4\frac{2}{5}$-Inch.	
Ordnance, Brass, ...	...	...	...	...	...	...	20	20	Equal number with the large Mortars and Howitzers; one-half of each Nature of small Mortars.
Ordnance, Iron, ...	40	20	5	10	10	15	...	...	In proportion of 6 Guns to 4 Mortars and Howitzers.
Carriages complete, Travelling with Limbers,... ...	40	20	5	10	...	...	...	...	
Mortar Beds with Coins, Wood, ...	...	...	...	...	...	...	20	20	
Mortar Beds with Coins, Iron, ...	...	...	...	...	10	15	...	...	
Handspikes, Traversing, ...	...	20	...	10	...	...	...	...	Heavy pieces at 4 each; Light at 2 each.
Handspikes, Common, ...	160	40	20	20	40	30	...	...	
Hand Crow, Levers, 6 feet, ...	40	20	5	10	10	...	...	...	
Iron Crows, $5\frac{1}{2}$ feet, ...	4	2	1	1	1	1	...	...	One for every 10 pieces of Ordnance.
Spunges with Staves, Rammers and Bags, ...	80	40	10	20	10	15	20	20	
Wadhooks with Staves, ...	10	5	...	...	...	...	...	...	One for every 4 Guns.
Ladles, ditto, ...	10	5	...	...	...	...	...	...	Ditto.
Jacks Handscrew, large,...	10	5	2	3	...	...	...	...	One for every 4 Guns and Howitzers.
Grease Boxes, ...	40	20	5	10	...	...	...	...	
Linstocks with Cocks, ...	40	20	5	10	10	15	20	20	
Claw Hammers, ...	40	20	5	10	10	15	...	...	
Punches for Vents, ...	80	40	10	20	20	30	40	40	
Priming Irons, long, sets, ...	40	20	5	10	10	15	20	20	
Portfire Clippers, pairs, ...	20	10	3	5	5	8	10	10	

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Detail of Battering Train, (continued.)

ORDNANCE AND IMPLEMENTS.	Guns.		Howitzers		Mortars.				
	24-Pounder.	12-Pounder.	10-Inch.	8-Inch.	10-Inch.	8-Inch.	5½-Inch.	$4\frac{2}{5}$-Inch.	
Powder Horns, New Pattern, ...	40	20	5	10	10	15	20	20	(Now obsolete.—*Ed.*)
Gun Locks, ...	44	22	6	11	...	...	.	...	One every Gun and Howitzer, and 1-10th spare.—*Id.*
Musquet Flints, 2000, ...	...	...	...	...	...	...	...	...	Or about 25 Flints per Lock.—*Id.*
Cylinders of Wood and Leather, for Cartridges,	80	40	...	...	...	...	...	...	
Junk Wads, ...	4000	2000	...	...	...	...	...	...	One in 10 Rounds. (Recently ¼ Solid, ¾ Grummet.—*Ed.*)
Straps, for Side Arms, ...	40	20	5	10	...	...	...	...	Sets complete.
IMPLEMENTS, LABORATORY STORES.									
Men's Harness, heavy, sets, ...	80	20	10	10	20	15	...	...	Having an additional pair of loops, to increase them to 16 a set, 2 sets for every 24-Pounder and 10-Inch Mortars and Howitzers, and one set for the others.
Leather Buckets, ...	80	40	10	20	20	30	4	4	
Marline, skeins, ...	40	20	5	10	10	15	...	...	
Hambro' Line, skeins, ...	40	20	5	10	10	15	...	...	
Common Spikes, ...	200	100	25	50	50	75	...	...	Five for every piece of Ordnance.
Spring Ditto, ...	...	...	...	...	...	...	...	...	
Spare, Spunge Staves, ...	80	40	10	20	10	15	20	20	
Spare, Heads, Spunge, ...	80	40	10	20	20	30	20	20	
Spare, Heads, Rammer, ...	80	40	10	20	...	...	...	...	
Spare, Forelock, Keys, ...	80	40	10	20	...	...	...	...	
Spare, Forelock, Rings, ...	80	40	10	20	...	...	...	...	
Spare, Linch-pins, Fore, ...	80	40	10	20	...	...	...	...	
Spare, Linch-pins, Hind, ...	80	40	10	20	...	...	...	...	
Spare, Washers, Fore, ...	80	40	10	20	...	...	...	...	
Spare, Washers, Hind, ...	80	40	10	20	...	...	...	...	
AMMUNITION AND LABORATORY STORES.									
Shot, Rounds, ...	40,000	24,000	...	...	...	...	...	...	1000 Rounds each 24-Pr., 1,200 each 12 Pr.
Shot, Case, Common, Tin Shot, ...	2000	1000	...	...	...	...	...	...	50 Rounds a Gun.
Shot, Case, Spherical, ...	4000	2000	...	3000	...	...	...	...	100 Rounds a Gun, and 300 for 8-Inch Howitzer.
Shot, Round, Rounds, 100 each, ...	...	...	...	...	500	...	...	...	50 for each 10-Inch Mortar.

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Detail of Battering Train, (continued.)

AMMUNITION AND LABORATORY STORES CONTINUED.	Guns.		Howitzers		Mortars.				
	24-Pounder.	12-Pounder.	10-Inch.	8-Inch.	10-Inch.	8-Inch.	5½-Inch.	4⅖-Inch.	
Shells, common, empty, ...	...	...	3000	3000	6000	9000	4000	4000	
Carcasses, Round, fixed, ...	...	...	50	100	100	150	...	...	10 Rounds for each 10 and 8-Inch Mortar and Howitzer.
Wood Bottoms, for Round Shot, ...	...	...	...	...	500	...	...	...	
Valenciennes Composition, ...	...	...	500	...	1000	...	...	...	100 proportion each 10-Inch Mortar and Howitzer.
Gun Powder, Large Grain, whole barrels of 90 lbs. each, ...	3455	1066	194	333	466	400	66	44	This is calculated for the No. of Rounds at the service charge, and is required exclusive of Powder in Cartridges. The fine Powder forms part of the 24-Prs. calculation, and is placed in that column, but it is intended for the several service, or the equipment, and is calculated at 2 whole barrels per piece
Gun Powder, Fine Grain, half barrels of 45 lbs. each, or 18,000 lbs., ...	400	...	...	...	...	...	...	...	
Gun Powder, Mealed, lbs., ...	40	20	5	10	10	5	...	...	One lb. for every piece.
LABORATORY STORES.									
Flannel Cartridges, Field Service Charge, ...	6000	3000	500	1000	...	...	...	...	
Flannel Cartridges, Empty. For Service Charge,	44,600	26,700	2850	5700	...	...	...	...	1 Cartridge for each Round, including those filled, with 1-10th spare.
Flannel Cartridges, Empty. 8 Ounces, ...	...	...	...	...	...	...	2000	2000	Cartridges equal to half the No. of Rounds.
Paper Caps for Cartridges, ...	20,000	12,000	...	...	...	...	...	...	As a substitute for Wads, if wanted, 1 for 2 Rounds.
Twine for choking Cartridges, one hundred pounds, ...	...	...	...	...	...	...	...	...	One lb. of each for every 1000 Cartridges.
Pack Thread ditto ditto, one hundred pounds, ...	...	...	...	...	...	...	...	...	
Fuzes, graduated, Spherical, ...	8000	4000	...	6000	...	...	...	...	2 for each Spherical Shell.
Fuzes, graduated, Common, ...	...	...	4500	4500	9000	13,500	6000	6000	1½ for each common Shell.
Fuze Augers, ...	20	10	...	10	...	...	...	...	One for every 2 Guns, and 1 for each 8-Inch Howitzer.
Tubes, Brass, One hundred and twenty-seven thousand, being	..	...	...	...	...	...	...	...	One for each Round, and 1-5th spare. (Recently ¾ Friction, and 1-10th spare.—*Ed.*)
Tube Pockets with Straps, ...	80	40	10	20	20	30	20	20	

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Detail of Battering Train, (continued.)

LABORATORY STORES.	Guns. 24-Pounder.	Guns. 12-Pounder.	Howitzers 10-Inch.	Howitzers 8-Inch.	Mortars. 10-Inch.	Mortars. 8-Inch.	Mortars. 5½-Inch.	Mortars. $4\frac{2}{5}$-Inch.	
Match, Slow, ...	10	5	1¼	2½	2½	3¾	1	1	¼ Cwt. for each heavy piece, and the same quantity for 2 small Mortars.
Match, Quick, Lengths, ...	...	...	...	...	6000	9000	...	...	
Match, Quick, In Balls, yards, 400, ...	...	...	...	...	...	...	...	...	
Portfires, Long, Small, 3000, ...	...	...	...	...	...	...	...	...	One for every 12 Rounds, 1-3rd of which common Portfires, 2-3rds Blue Paper.
Portfires, Blue Paper, 6000, ...	...	...	...	...	...	.	...	...	
Portfire Sticks, ...	80	40	10	20	20	30	20	20	
Cutting Knives, ...	40	20	5	10	10	15	20	20	
Scissors, pairs, ...	40	20	5	10	10	15	20	20	
Worsted, lbs.	10	5	1	3	...	...	...	...	¼ lb. each Gun and Howitzer.
Needles, ...	120	60	15	30	...	...	...	...	3 Needles each ditto ditto.
Thumbstalls, ...	80	40	10	20	20	30	20	20	
Copper Powder Measures, 4 lbs. to one ounce, Sets, ...	8	4	1	2	2	3	...	...	A Set for 5 pieces.
Copper Scales with Beams, pair, ...	...	...	...	...	2	3	2	2	One in 5 for large Mortars. One in 10 small ditto.
Brass Weights, 4 lbs. Piles, ...	...	...	...	...	2	3	2	2	Ditto. Ditto.
Mallets, ...	...	...	5	10	10	15	20	20	One Mallet and 2 Setters for each Mortar and Howitzer.
Setters, ...	...	...	10	20	20	30	40	40	
Tenon Saws, ...	20	10	3	5	5	8	10	10	One for every 2 pieces.
Setters for Saws, ...	20	10	3	5	5	8	10	10	
Files, 3 square, ...	20	10	3	5	5	8	10	10	
Quadrants, Brass, ...	...	...	1	2	2	3	...	...	One for every 5 10-Inch Mortar and Howitzer.
Perpendiculars, ...	...	...	1	2	2	3	...	...	Ditto. Ditto.

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Detail of Battering Train, (continued.)

LABORATORY STORES.	Guns.		Howitzers		Mortars.				
	24-Pounder.	12-Pounder.	10-Inch.	8-Inch.	10-Inch.	8-Inch.	5⅘-Inch.	$4\frac{2}{5}$-Inch.	
Box Rules, ...	8	4	1	2	2	3	...	...	A Rule for 5 Pieces.
Compasses, ...	...	...	1	2	2	3	...	...	One for 5 Mortars and Howitzers.
Funnels, { Tin, ...	10	5	3	5	5	8	10	10	One in 4 for Guns ; one in 2 for Mortars and Howitzers.
Funnels, { ditto, for loading, ...	...	...	...	...	5	8	...	...	One in 2 for large Mortars.
Cork Screws, ...	10	5	3	5	5	8	10	10	One in 4 for Guns ; one in 2 for Mortars and Howitzers.
Engines for drawing Fuzes, ...	...	...	1	2	2	3	...	...	One in 5.
Pincers, pairs, Iron, ...	...	...	...	...	...	...	4	4	One in 5.
Scrapers for Shells, ...	...	...	3	5	5	8	10	10	
Lead Plummets, ...	...	...	...	...	10	15	20	20	
Shell Hooks, pairs, Hand, ...	...	...	10	...	20	...	...	...	
Cartouches, Leather, large, ...	40	20	5	10	15	15	20	20	One for each large Mortar and Howitzer, and 1 for five small Mortars.
Budge Barrels, Hazle Hooped,...	...	...	5	10	15	15	5	5	
Blue Lights, one hundred, ...	...	...	...	...	...	...	...	...	For Signals.
Hazle Hoops for Powder Barrels, ...	...	...	...	...	...	...	...	...	A Hoop for 10 Barrels if used.
Copper, { Adzes, ...	...	...	...	...	...	...	...	...	A Set for every 500 Barrels of Powder, if barrels are used.
Copper, { Drivers, ...	...	...	...	...	...	...	...	...	
Copper, { Vices, ...	...	...	...	...	...	...	...	...	
Copper, { Can Hooks, pairs, with Slings. ...	...	...	...	...	...	...	...	...	

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Spare, Transporting, and other Carriages for Battering Train.

	Spare Carriage Ordnance.				Wag-gons.			Carts.			Carriages.				
											Devil.				
	24-Pounder.	12-Pounder.	10-Inch.	8-Inch.	Flanders Pattern.	Store.	Forge.	Hand with Shaft.	Sling.	Trench.	Large.	Small.	Platform.	Large Drags.	Small Drags.	
Number of Carriages, ...	4	2	1	1	100	10	10	50	...	2	...	2	25	5	5	One spare Carriage for 10 pieces of Ordnance.
Covers, { Waggon, Painted, ...	...	...	...	...	100	...	...	...	...	...	...	...	...	...	...	
Covers, { Cart, do.	...	...	...	...	...	...	...	50	...	...	...	...	...	...	...	
Grease Boxes, ...	4	2	1	1	100	10	10	...	...	...	...	...	25	...	...	
Jacks, Handscrew, large, ...	...	...	...	...	...	...	...	...	...	...	...	...	6	...	...	
Linch-pins, spare, ...	...	...	...	...	...	...	...	...	...	...	..	...	...	...	...	1 per Carriage.
Chests of Tools, Anvils, and Blocks, & Buck Irons,	..	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Forges to be completed with these articles.

HORSE HARNESS FOR CARRIAGES.

		Platform.	Single Wheel.	Single Leader.	General Total.	
Horse Harness complete, with Whips, Leggings, and Head-stalls Halters with Chain Reins,	Wheel, ... 8 4 2 2 200 20 20	50	306	...	306	18 Platform Waggons are at 8 Horses each, the Mortars and the remaining 7 at 4 Horses each.
	Leader, ... 16 4 4 2 200 20 20	122	...	388	388	
	Off Wheel, ... 50 ... 50 ...	...	100	...	200	

HORSE HARNESS FOR ORDNANCE.

		40 24-Prs. at 10 Horses.	20 12-Prs. at 6 Horses.	5 10-In. How. at 10 Horses	10 8-In. How at 6 Horses.			
Horse Harness complete, with Whips, Leggings, Head Stall, Halters, with Chains, Reins, &c.	Wheel,	80	40	10	20	150	...	150
	Leaders,	320	80	40	40	...	480	480
	General Total Harness,					556	868	1524

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Detail of Battering Train, Continued.

GENERAL STORES.			No.	
Triangle Gyn, Common, ...			8	About one for every 12 pieces.
Iron Blocks with Brass Sheaves,	Treble, ...		...	
	Double, ...		...	
White Rope, fathoms	6-Inch, for slings, ...		...	Complete for 8 Gyns.
	4-Inch, for falls, ...		...	
Crab Capstan complete, ...			2	One for 50 pieces.
Purchase Blocks with Brass Sheaves,	Treble, ...		5	
	Double, ...		5	One for 20 pieces.
	Single, ...		5	
Tarred Rope, Coils, 4½ Inch, ...			4	One for 25 pieces.
Blocks,	Double.	10 Inch, ...	8	
		8 do. ...	8	
	Single,	10 do. ...	8	Equal to number of Gyns.
		8 do. ...	8	
		5½ do. ...	8	
Rope, Coils,	Tarred,	4 do. ...	4	One for 25 pieces.
		3 do. ...	5	One for 20 do.
		2 do. ...	5	Ditto ditto.
		1 do. ...	10	One for 10 do.
	White,	6 do. ...	1	
		4 do. ...	1	
		3 do. ...	1	
		2 do. ...	1	
Spun Yarn, Coils, ...			5	One ton for 20 pieces.
Ratline, do.			5	Ditto ditto.
Iron of sorts, Tons, ...			2	One ton for 50 pieces.
Steel, cwts,	Shear, ...		1	Half cwt. for each 50 pieces.
	Blister, ...		1	
Coals, Chaldrons, ...			5	A chaldron for 20 pieces.
Candles, cwts., ...			1	
Grease, Kegs,...			200	2 per piece.
Lanthorns,	Muscovy, ...		10	One for 10 pieces.
	Tin, ...		20	One for each 5 pieces.
	Dark, ...		20	
For Security of powder,	Tanned Hides, ...		50	One for 2 pieces.
	Wadmiltilts, ...		50	One for 2 pieces.
	Hair Cloths, ...		100	One per piece.
	Tarpaulins,	30 feet by 15,	25	One for 4 pieces.
		20 ... by 16,	25	One for 4 pieces.
		14 ... by 10,	100	One per piece.
Horse Shoes, with 3 sets of nails to each, ...			...	Three sets of shoes for every single horse harness.
Shoeing Tools, ...			...	One set of shoeing tools for every 50 single horse harness.
Park Pickets,...			...	One for 5 single horse harness.
Wood Mauls,...			...	One for 10 pickets.
Nose Bags, New Pattern, ...			...	Three for every two horses' harness.
Corn Sacks, ...			...	A sack for every four horses' harness.
Forage Cords, Sets, ...			...	One for every two horses' harness.
Additional Head Collars, ...			...	One in five of number of single sets of harness.
TOOLS.				
Chests of Tools,	Collar makers		4	One for 25 pieces.
	Wheelers,		8	One for 12 pieces.
	Smiths, ...		4	One for 25 pieces,
	Coopers, ...		2	One for 50 pieces, if *barrels* are used.
Heavy Sledge Hammers, ...			4	For knocking off trunnions.
Wrench Hammers, of sizes, ...			10	One for 10 pieces.
Intrenching Tools,	Axes,	Felling, ...	50	One for 2 pieces.
		Pick, ...	100	One for each piece.
	Spades, ...		100	Ditto.
	Shovels, ...		100	Ditto.

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Detail of Battering Train, Continued.

GENERAL STORES.				No.	
Intrenching Tools,	Hand,	Bills,	...	100	One for each piece.
		Hatchets,	...	100	Ditto.
	Barrows,	Hand,	...	50	One for 2 pieces.
		Wheel,	...	50	Ditto.
	Grindstone with Trough,		...	2	One for 50 pieces.
	Helves for	Spades,	...	50	Half spare.
		Shovels,	...	50	
		Axes, Felling,		25	
		Axes, Pick,	...	50	
	Saws,	Pit,	...	2	
		Crosscut,	...	2	
		Hand,	...	10	One for 10 pieces.
	Setters for Saws,	Pit,	...	2	
		Crosscut,	...	2	
		Hand,	...	2	
	Files for Saws, dozs.,	Pit.	...	2	
		Crosscut,	...	2	
		Hand,	...	3	
Nails,	Clasp,	40 penny,	...	3000	30 Per piece.
		30	...	2000	20
		20	...	4000	40
		10	...	4000	40
		6	...	2000	20
	Streaks of sorts,		...	3000	30 of sorts per piece.
Marlin Spikes,			...	4	
Screws of sorts, grosses,			...	10	One gross for 10 pieces.
Glue, lbs.,			...	10	One pound for 10 pieces.
Oak Skidding. 8 by 8 running,			...	80	
Oak Plank, 3 inch, ends,			...	...	
Planks, superficial feet,	Elm,	1-inch,	...	50	
		¾	...	50	
	Ash,	1½	...	...	
		1	...	...	
Deals,	Sawed,		...	25	One in 4 pieces.
	Whole,		...	25	Ditto.
Iron Shot Guages, sets			...	4	
Brass Callipers, Large, pairs,			...	2	
Grates for Heating Shot,			...	3	One for 20 Guns.
Fire Irons for do., sets,			...	...	In proportion to the Grates.
Shot Bearers,			...	...	
SPARE.					
Wheels,	24-Pounder,	Gun,	...	8	One for every 10 Wheels on Gun and Howitzer Carriages, and one for every 20 Wheels on Gun and Howitzer Limbers, and on all other Carriages.
		Limber,	...	4	
	12-Pounder,	Gun,	...	4	
		Limber,	...	2	
	10-Inch,	Howitzer,	...	1	
		Limber,	...	...	
	8-Inch,	Howitzer,	...	2	
		Limber,	...	1	
	Waggons,	Flanders Pattern, Fore		10	
		Flanders Pattern, Hind,		10	
		Forge,	...	2	
	Platform Carriages,	Fore,	...	3	
		Hind,	...	3	
	Carts,	Sling,	...	2	
		Hand,	...	5	
		Trench,	...	5	
Axletrees, Iron, whole,		24-Pounder,		5	One in 10 of Ordnance, with Beds of Wood in proportion.
		10-In. Howr.		5	
		12-Pounder,		3	
		8-In. Howr.		3	

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Detail of Battering Train, Continued.

GENERAL STORES.	No.	
Axletree Arms, Iron, of sorts, ...	35	One in 10 of Carriages, with Beds of Wood in proportion.
Common Handspikes, ...	300	3 spare per piece.
Traversing Handspikes, ...	15	One for every 2 12-Pounders and 8-Inch Howitzers.
Bale Hoops, ...	200	2 for each Flanders Pattern Waggon.
In the Rough.		
Spokes of sorts.	...	In quantity equal to the number of spare Wheels.
Felloes, ...	...	
Shafts of sorts	70	One in 5 of the number of Carriages.
Splinter Bars of sorts, ...	25	One in 10
Guides, Fore, ...	12	One in 20 Of all four wheeled carriages.
Guides, Hind, ...	12	One in 20
Under Poles, ...	10	
Raves, ...	10	One in 10 of each for Flanders Pattern Waggon.
Tail-pieces	10	
Sweep Bars, ...	10	
Shaft Bars of sorts, ...	25	One in 10 for four wheeled Carriages.
Iron Tire, ...	...	Equal to one-fourth the materials for repairing Wheels.
Camp Equipage, ...	...	In proportion as heretofore, according to the numbers requiring it.
Laboratory Tents complete, with Poles, Pins and Mallets, ...	5	One in 20 pieces.
Collar Maker's Materials, *For Three Months,*		
Harness, Leather, hides, Stout, ...	14	1 hide.
Harness, Leather, hides, Light, ...	7	½ do.
Basils of sorts, dozens, ...	28	2 dozen.
Webb, yards, Gunner's Girth, ...	112	8 yards.
Webb, yards, Surcingle, ...	42	3 do.
Pannel, Serge, yards, ...	70	5 yards.
Does Hair, or Curled Hair, lbs, ...	210	15 lbs,
Thread, Hemp, ...	42	3 ...
Thread, Collar, ...	28	2 ...
Thread, Dutch, ...	28	2 ...
Harness and Bridle Buckles of sorts, dozens, ...	42	3 dozen.
Nails of sorts, ...	7000	500 nails.
Tacks of sorts, ...	7000	500 tacks
Bristles, lbs.	7	½ lb.
Needles of sorts, ...	1400	100 needles,
Whipcord, lbs.	21	1½ lb.
Tin Pans for Oil, ...	42	3 pans.
Wax, lbs., Black, ...	14	1 lb.
Wax, lbs., Bees, ...	7	½ ...
Neats foot Oil, gallons, ...	21	1½ gallons.
Tallow, lbs., ...	14	1 lb.
Punches of sorts, ...	140	10 punches.
Awls, ...	140	10 awls.
Horse Medicines, ...	...	A proportion.

To 100 sets of Single Harness.

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(Note by the Editor.)

The following is a list of the Carriages composing the Battering Trains, despatched from the Royal Arsenal to the seat of war in 1854-5, down to the end of December, 1854. It is understood that the composition of each of the divisions yet to follow, will be 16 8-Inch Guns of 52 cwt.; 21 32-Pounder Guns of 50 cwt.; and 10 10-Inch Mortars; with as many other Carriages as may be required.

1854.		Guns, Gun Carriages, and Limbers.				Mortars and Beds.		Waggons.					Drags.		Carts.		Platforms.		Gyns, Triangle, large.	Capstans, Crab.	
		8-Inch.		32-Pounder. 50 Cwt.	24-Pounder. 50 Cwt.	10-Inch Iron.	5½-Inch Wood.	Platform.	Sling.	Flanders.	Store Limber.	Forge.	Large.	Small.	Hand.	Trench.	Alderson's.	Madras.			
		65 Cwt.	52 Cwt.																		
May.	1st Battering Train,		11		16	5	10	5	2	6	6	5	1	2	15	15	5	25	3	3	
July,	2nd „		11		16	5	10	5	2	6	6	3	1	2	15	15	5	25	3	2	
November,	3rd „		11	21	...	10	10	10	2	6	6	3	1	2	20	20	10	30	3	2	

* These include one spare Gun Carriage.

Note.—The Companies of Artillery attached to the Siege Train, consisted of 5 Officers, 14 Non-Commissioned Officers, 118 Gunners and Drivers, and 2 Trumpeters. Total, 139.—*Ed.*

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Bouched Guns.

The whole of the Guns of the third and following Divisions of the Battering Trains, referred to at page 235, were, or will be bouched with *wrought iron*, before being issued, as were also the 24-Prs. of the 1st. and 2nd. Divisions.—*Ed.*

Observations with regard to the foregoing Equipment of Battering Train.

Ordnance.

1. The proportion fixed on is six Guns to four Heavy Mortars and Howitzers, which, in the consideration of the Sub-Committee, may in general be adhered to with propriety, as well with the smallest, at with the largest Battering Equipments; and they feel fully borne out in this opinion by our principle Armaments during the late War, as well as by the most modern French details for equiping Battering Trains.

2. With every Battering Equipment there should be sent a portion of small Mortars, in no case fewer in number than the Heavy Mortars and Howitzer with the same; but this proportion ought to be augmented in all equipments of less than 30 pieces; indeed, when sent at all there should be at the least 12 of them to ensure the necessary effect. In many cases a far greater number than is here proposed could be advantageously used, but this must be decided by the circumstances of the Service the Train is likely to be employed on.

In the present instance, the Royal and Cohorn Mortars have been taken in equal proportions, and it would be advisable to adhere to this on the larger Battering Trains, particularly where this Caliber corresponds with the Guns; but in small equipment, it would be more convenient to confine the arrangement to one nature, and in which case the Royal Mortars is preferable, as it possesses the power of being used at a greater distance, and a complication of ammunition is avoided; at the same time it is to be observed, that the Cohorn, from its lightness, and small weight of ammunition, is a most desirable implement to employ in the closer part of attack.

3. The Sub-Committee propose to employ with Battering Trains, Iron 12-Prs, 8½ feet long, in the proportion of one-third of the number of Guns, as a 12-Pounder of this description is conceived to be sufficiently powerful for annoyance and direct fire to dismount the enemy's Artillery, as well as for firing *en ricochet* and the diminished weight of ammunition is an important advantage attending the employment of this nature: but it is an arrangement that can be admitted only in cases where there is an adequate number of 24-Pounders, and it would therefore be better with small equipments, that all the Guns should be of the Heavy Caliber.

[*W.*] I doubt this, considering the strength of modern parapets and traverses.

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[*C.*] These guns have been assumed on the qualified supposition, that there is an adequate number of 24-Pounders for the more serious operations of a siege, and are rather taken on account of the facility of their movement, and the lightness of their ammunition for the purposes of annoying and dismounting the enemy's guns by direct fire, than for the exclusive purpose of ricochet, which latter application of projectiles, it is believed, will rarely effect the breach in the present state of defensive warfare, except when used with the heaviest Ordnance, such as 10 and 8-Inch Howitzers.

4. The equipment is made on a supposition of the new Iron 10-Inch and 8-Inch Howitzers being introduced into the service, as they certainly would be far more durable than those of brass, which generally are injured by their own fire before they have expended two or three hundred rounds, besides the new Iron 8-Inch Howitzer, is well calculated to fire Spherical Case, which the Brass 8-Inch Howitzer cannot do; and the 10-Inch Iron Howitzer has the important advantage of being mounted on a Travelling Carriage. (The pieces referred to are those now in the service, and which were introduced by Colonel Millar, in 1820.—*Ed.*)

Ammunition.

5. In arranging the proportions of Ammunition for all Battering Equipments, it would be a good principle to establish that they should be of three descriptions, viz:—

	Rounds per Gun.
Large, for the Siege of a Fortress of the 1st Class, say	1500
Medium, for the Siege of a second rate Class,	1000
Small, for the attack of a place or post, but slightly fortified, and not requiring a regular attack,	500

The Ammunition in the present case is calculated as follows:—

1000 Rounds per Gun, exclusive of Case Shot and Spherical.
600 Rounds per large Mortar and Howitzer. } Exclusive of Carcasses and Rounds of pound Shot.
200 Rounds per small Mortar.

[*W.*] I believe 1000 rounds each Gun, but more Guns would be better and cheaper.

[*C.*] In many cases, more Guns, with the same quantity of ammunition, would be better and cheaper.

But as each Battering Train must be formed in reference to its particular destination, little more than a general outline, subject to modification, could be traced.

The only deviation from this principle is with regard to the 12-Pounders, which are calculated at 1,200 Round Shot each, as the fa-

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cility of working these Guns will at an easy rate, afford the power of firing more rapidly than the 24-Pounders, and be the means of saving ammunition in cases where more annoyance is the object.

The proportion of one-half Common Shells, and one-half Spherical for the Iron 8-Inch Howitzers, should always be adhered to.

6. In correspondence with the foregoing, it ought to be considered as a fixed principle of equipment in all cases, that the proportion of Ammunition required should be of Round Shot and Shells, to the full amount demanded, independent of the requisite quantity of Case Shot, Common Spherical, Carcasses, &c.

7. The use of Tier Shot for the Guns, instead of Grape, is deemed most advantagious, as the former contains a far greater number of Balls, and of a sufficient magnitude for the purpose required.

8. The Powder is calculated at the following rates.

For Guns.—The Service Charge for the whole number of rounds, including Case Shot and Spherical:—

For 10-Inch Howitzer and 10-Inch Mortar. } 7 lbs. each round, including powder for filling for the whole number of rounds.

8-Inch Howitzer, at 6 lbs. ditto, ditto ditto.

8-Inch Mortar, at 4 lbs. each round, including powder for filling, for the whole number of rounds.

5½-Inch Mortar, at 1½ lbs. ditto, ditto ditto.

4½-Inch Mortar, at 1 lb. ditto, ditto ditto.

It is considered requisite that the Powder should be to the full extent in quantity of the above detail, in order to provide for the loss that may arise on landing it on a difficult beach, and the injury it may sustain from bad weather whilst moving with the Train, as well as the casualties it is under all circumstance liable to, but more particularly those that occasionally occur from the explosion of Expense Magazines in the Batteries, &c., to which may be added the supplies frequently required by the Engineer Department.

9. The Sub-Committee propose, that part of the above-mentioned Powder should be sent, made up in Cartridges, in the following proportion, viz.:—

150 Rounds per Gun,
100 Rounds per Howitzer, } At the full Charge.

By this arrangement, the Train will possess the advantage of always having a day's firing in readiness, and it will derive a far greater one in the use of the boxes containing the made-up Cartridges, as they will be of infinite service for the safe conveyance of the Ammunition to the Batteries during the whole siege.

10. Two or more barrels of fine grained Powder per piece, always to accompany the Train as a part of its calculated proportion; this will serve for making up Small Arm Ammunition, or any other purpose for which it may be required, and be equally available for the Service of the Ordnance.

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11. It is a great object that some improvement should be made in the security of Powder for land movements, it being so liable to be damaged by weather, when conveyed in the present Powder Barrels, as they do not resist wet in the smallest degree: and at the same time, are apt to shake and get out of order by long marches, or by moving on rough roads like the Chaussees on the Continent, by which means Powder is frequently scattered along the road in such a manner, as to occasion imminent risk of explosion; the Committee, therefore, with a view of remedying these serious objections to the Powder Barrel for protracted Land Carriages, beg to propose, that a box lined with lead, of the same capacity as the barrel, should be substituted; which would be secure against all common accidents of weather, not liable to get out of order, and more compact for conveyance, either in Waggons or on Mules; and in furtherance of this, the Committee have had a box of this description prepared in the Arsenal, which they beg to submit, and at the same time have to observe, that although the box weighs rather more than the barrel, and the original expence is something greater, yet the advantages arising from the durability stowage, and portability of the box, will more than compensate the trifling difference of weight and price. To this is to be added, the advantage of doing away a workman absolutely necessary for opening and closing up the barrel, and keeping it in repair.

[*W.*] Would not the caulked box answer, and be lighter and less expensive, and less liable to be stolen?

[*C.*] The desiderata required are strength, simplicity, durability, and stowage; all these, together with the security to the powder, are combined in the proposed box, which also contains nothing on account of which it may be liable to be stolen. It is considered by artificers the best of several boxes made for the purpose, and is nearly similar to that adopted for the navy.*

Cartridges.

12. It is highly requisite that the Cartridges, both filled and empty, should be of flannel, and, under the uncertainty of the application of fire, that they should be all for the full charge: but in the event of firing *en ricochet*, they can be cut in such a manner, that the part taken off will serve to make another ricochet Cartridge.

Their being of flannel with Battering Trains is thus strongly urged, in consequence of the many accidents that occur on service from Paper Cartridges breaking whilst conveying through the Trenches, and also in the Batteries, which very often occasion explosions, attendant with casualty, and consequent delay and confu-

* The Powder has been shipped, for the service of the Battering Trains in the Crimea, in the naval metal-lined case, each of which contains 120 lbs., and be regarded as, to that extent, a portable magazine, from the great facility with which it can be opened, and the security of the contents.—*H. C.*

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sion; to this may be added the safety that Flannel Cartridges afford in the service of the Guns, whilst keeping up the rapid and vigorous fire so necessary in a siege.

One-tenth spare of Cartridges is requisite to provide for loss by accidents, and also to afford the power of a second time firing shot that may be collected about captured out-works, and from the body of the place when taken, in the event of there being a Citadel to attack.

Fuzes.

13. Although it is difficult to recommend any reform with regard to Fuzes, on account of the immense number of Shells at present in store, the Sub-Committee, nevertheless, deem it a matter highly deserving of consideration, that there should be fewer natures of Fuzes in the service, and they see no reason why the five now in use might not be diminished even to two, for both Common and Spherical Shells, in the following manner, viz.:—

13-Inch Fuze, 10 Do. Do.	To be of the same size, graduated, and numbered 1.	By the 13-Inch Shells hereafter being cast with fuze-holes of the same size as the 10-Inch.
8-Inch Fuze, $5\frac{1}{2}$-Inch Do. $4\frac{2}{5}$-Inch Do.	To be of the same size, graduated, and numbered 2.	By the 8-Inch Shells hereafter being cast with fuze-holes of the same size as the $5\frac{1}{2}$-Inch, and by the present $4\frac{2}{5}$-Inch Common Shells being reamed up to the $5\frac{1}{2}$-Inch.

In the mean time, the Committee beg to recommend, that all the common Fuzes now in the service should be fitted and graduated in the same manner as those for Spherical Case.

The Committee also strongly recommend, that in future, the Spherical Fuze-holes should not be tapped, but left smooth, and the Fuze driven in as with Common Shells.

14. In reducing the Fuzes to two natures, the Sub-Committee propose, that the larger size No. 1, for 13-Inch and 10-Inch Shells, should be of two lengths, for Land and Sea Service; and that the smaller Fuze No. 2, should be made also of two lengths, one of which having four inches, and the other two inches of composition; the latter of two inches would be applicable to the 8-Inch Shell for short ranges, and to the $5\frac{1}{2}$-Inch and $4\frac{2}{5}$-Inch Common, and all Spherical Shells in the service.

In making equipments on this arrangement, *all 8-Inch Shells* to be supplied with No. 2 four-inch Fuzes, and all *Spherical and smaller Common Shells* with No. 2 two-inch Fuzes.

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15. The arrangement of cut Spherical Fuzes not being deemed necessary for a siege, it is considered that two whole Fuzes of this nature per Shell, are sufficient for all purposes.

(Additional Note on Fuzes.)

Very great improvements have been recently introduced in the article of Fuzes; for most of which the service is indebted to Captain E. M. Boxer, R.A., now Firemaster. Under that Officer's superintendence, the recommendation of the Committee have been, for the first time, carried out, by the adoption of one uniform size of Fuze-hole for each of the classes grouped in Section 13; but the reform has also been carried much further. By the aid of extensive and very beautiful machinery, the most perfect uniformity has been attained in the manufacture of the Fuze itself, whether in wood as for land service, or in metal as for sea service; the Shells are prepared for the Fuzes, the Fuze-holes being reamed to their true dimensions with precision: the ignition of the composition is secured by a new and simple method of priming, and the tedious process of cutting the Fuze, or boring out the superfluous composition, is saved by the ingenious mode of construction which bears the inventor's name; and which is now too well known to the service to need description. The practice in the Peninsula war was to carry as many as six lengths of bored Fuzes, distinguished by different letters and colours; making, with the Fuze unbored, and with the two-tenths Fuze of *mealed powder*, lettered A, no less than eight varieties: a complication, which is now entirely avoided.—*Ed.*

Tube Pockets.

16. Tube Pockets are mentioned in the equipment, as it is conceived that a leather bag, for containing Tubes, would be more convenient to wear than the tube box now in use; these to be the same pattern as those proposed for Field Service.

Wadding.

17. In future, Junk Wads not to be sent with Battering Equipments, with the exception of a proportion equal to one-tenth of the number of Round Shot, for the purpose of being use when firing Hot Shot when required. In the event, therefore, of Guns firing with depression, some kind of Wadding being requisite, Paper Cases for Cartridges are proposed to be used, and a proportion is included in the equipment for this purpose, equal to half the number of Round Shot.

18. Should it be deemed necessary, in the first instance, to augment the quantity of ammunition, or to forward at any subsequent period an increased supply, it may be done in the proportion of one-half, or even of the whole of the ammunition stated in No. 5, without any further addition to the equipment; but of course the due quantity of Portfires, Tubes, Fuzes, Slow Match, empty Cartridges, &c., in conformity to the number of rounds, should be sent according to the proportions stated in the annexed detail.

Harness.

19. The calculation of Harness is made on the supposition of the whole of the carriages being in movement at once, which could only be necessary in the event of operations being carried on to a greater distance from the coast; for otherwise two-thirds of the Harness, or

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in some cases even one-half, would be sufficient; but this can only be regulated when the object of the train is known, and its destination not only to be changed.

The Collar-maker's materials are calculated for three months repairs, and they are in such proportions that they can easily be augmented or diminished, according to the quantity of Harness that is sent with the train.

20. In the annexed equipment, there is a Flanders waggon for every piece of ordnance, which appears a good portion to follow, whatever may be the size of the train. These waggons would be employed in conveying the Laboratory and other perishable Stores, as well as a proportion of Powder; but with regard to the transport of Shot, Shells, and Ammunition in general, the resources of the country must on all occasions be depended upon.

[*W.*] Whether it would not be desirable always to have a moveable equipment for one day's firing, say 100 rounds with each Gun?

[*C.*] It would evidently be most desirable to have a moveable equipment of a day's firing nearly; but this appearing to the Committee to make a considerable addition to the Battering Train Equipment, though contemplated, was given up: it can now be readily restored.

21. The Platform Waggons are calculated as follows:—

Ten 10-Inch Mortars, with Beds, require	10	Platform Waggons.
Fifteen 8-Inch Ditto Ditto,.	8	„
One Platform Waggon in five for Mortars spare,.....	4	„
One Ditto Ditto for every fifteen 24-Prs. and 10-Inch Mortars,.....	3	„
Total,.....	25	

The other Carriages are in the following proportions:—

Store Waggons, 1 in 10 of number of Ordnance.
Forge ditto, 1 in 10 ditto ditto.
Sling Carts, 1 in 10 ditto ditto.
Hand ditto, 1 for 2 pieces.
Trench ditto, 1 for 2 pieces.
Drags, { Large, 1 for 24 pieces. Small ditto.
Devil, small, 1 for 50 pieces. (Now Sling Waggon, *Ed.*)

The spare Gun and Howitzer Carriages are in the proportion of one in ten.

Axletrees.

22. The Sub-Committee having observed, that the 24-Pr. Battering Gun is the only one the Carriage of which has a wooden Axle-

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tree, they are persuaded that an iron one can be adapted to it with the greatest advantage, experience having shewn that it is the part most apt to give way, both in firing and travelling. The experience of the 18-Pr. Battering Ordnance moving in Spain and France durthe late Campaigns, as well as the late experiments with the 10-Inch Iron Howitzer, fully authorize this conclusion.

Men's Harness.

23. It being unnecessary to have with Battering Equipments both Drag-ropes and Men's Harness, it is proposed to discontinue the Drag-ropes, and instead of them, that the entire proportion should be of heavy men's harness, of the same length as at present used, which will admit of their having an additional pair of loops to each, to increase them to sixteen men to a set.

24. With regard to the next equipment, it is to be observed, that the stores in general are detailed in exact proportions according to the number of pieces, so as to be equally applicable to any augmentation or diminution of Ordnance, by which a general principle will be obtained for the future equipment of Battering Trains.

25. The Ordnance and Stores in the Equipment are classed in such a manner as to afford a facility of reference; and the Sub-Committee beg to propose, that the same order of classing may be pursued in future in drawing up returns of Battering Trains.

(Signed) WILLIAM MILLAR,
Colonel, Royal Artillery.
" WILLIAM ROBE,
Colonel, Royal Artillery.
" AUGUSTUS FRAZER,
Lieut.-Colonel, Royal Horse Artillery.
" ALEXANDER DICKSON,
Captain, R.H. Artillery, and Lieut.-Colonel.

Woolwich, April 10th, 1820.

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Memorandum of Artillerymen, at three and two Reliefs, required for the Siege of a Fortress, the Battering Train consisting of 100 *heavy Pieces.*

1. The Sub-Committee suppose that about three-fourths of the Ordnance would be brought into play at once, as follows:—

Detail of three Reliefs.

2. 25 24-Prs. at 6 men each,.....	150	N.C. Officers and Men.
20 12-Prs. at 5 men each,.....	100	„
4 10-Inch Howitzers at 6 men each,.....	24	„
16 10-Inch Mortars and 8-Inch Howitzers at 5 men each,	80	„
10 8-Inch Mortars at 4 men each,.....	40	„
75 Pieces of Ordnance,.....	394	
	3	
Total of three Reliefs for Batteries,	1182	„
For Laboratory duties,.....	50	„
Military Conductors, extra,.....	12	„
Reserve to replace casualties, &c., and to conduct Ammunition from the rear,.....	100	„
Total,.....	1344	

3. It is to be understood, that the whole numerical strength of the Companies, Non-Commissioned Officers and Drummers included, may be comprised in the above detail.

4. Detail of Artillery at two reliefs, on the event of the operations promising to be of short duration:—

One relief as before,.....	394	N.C. Officers and Men.
	2	
	788	
For Laboratory duties,.....	50	„
Military Conductors, extra,.....	12	„
Reserve to replace casualties, &c.,	150 at least	„
Total,.....	1000	

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5. The Sub-Committee observe, with regard to the reduced detail, that after the commencement of our fire, little or no aid could be obtained from the Artillery reliefs beyond their service in the Batteries; for those out of action would require rest, and no material exertion could be expected from them during the day of being off duty. All the arrangements for supplying the Batteries, therefore, and the various movements of Ordnance, both in charges from one Battery to another, and in arming new ones, done particularly by night, would become the immediate business of the reserve, which would have so much work to perform, that the calculation of 150 is taking it at as low a number as possible; and besides, it would daily diminish, as all the casualties in the Batteries would have to be immediately filled up from the number.

It is further to be observed, with regard to small Battering Equipments, that in all probability the whole of the Ordnance would be in operation at once, and a greater number of men in proportion to the pieces engaged would consequently be required.

6. Although these calculations are made on as moderate a scale as the nature of the service would admit, the Sub-Committee, nevertheless, are aware, that so great a portion of the Corps being always on detachment, it would be a matter of considerable difficulty to assemble a force of Artillerymen equal even to the smallest number in the foregoing statement: to meet this difficulty, therefore, it ought to be a matter of serious consideration in sending forth all Battering Equipments, what aid could be obtained, in the event of continental service, from the Field Artillery of the army, or from the Infantry as additional Gunners; and in like manner on maritime expeditions, what seamen could be spared to work the Guns, in addition to those usually furnished to convey ammunition &c., as heretofore: and by something of this kind being known, Artillerymen may be sent with the train in such proportion as will insure the carrying on of the service. At the same time, the Sub-Committee beg to express their conviction of the impossibility of any siege of duration, or one in a tropical climate, being vigorously carried on with fewer than three reliefs.

Note.—A Siege Train of the same extent as the above, constituted of such Ordnance as are at the present moment engaged before Sebastopol, and which are likely to be employed on all future occasions, will require a much larger force. We have now 32-Prs. of 50 cwt. taking the place of 24-Prs. of 48 cwt.; 8-Inch Guns of 50 cwt., taking the place of 10-Inch Howitzers of 40 cwt., and 8-Inch Howitzers of 20 cwt; 13-Inch Mortars, weighing with their beds, 69 cwt., added to 10-Inch Mortars, which weigh, with their beds, only 34½ cwt. The labor of serving these pieces is materially greater than before, requiring one or two more men to each, or taking three reliefs, requiring from three to six more men. The labor of bringing up ammunition, the quantity of transport and the number of men required, increases in even a higher ratio. It is probably not too much to affirm that a siege of the present day, requires one-third more Artillerymen in proportion to the extent of the Battering Train, than the Committee assigned.—*Ed.*

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Commissariat.

7. The Field Train Department required would be as follows:—

One Commissary.

Three Assistant's Commissary, { One for the Shipping. One for the Laboratory. One for the Park.

Eight Clerks of Stores. Eight Conductors of Stores.

Artificers.

8. The following Artificers would be required:—

One Master Artificer—a Wheeler; 5 Wheelers; 7 Blacksmiths; 5 Collar-makers; 2 Coopers, if powder barrels are used.

Articles of Equipment recommended to be abolished.

With Field Guns.	*With Battering Train.*
Aprons of Lead.	Aprons of Lead.
Muzzle Caps.	Tampions.
Drag-Ropes. See following return.	Muzzle Caps for Mortars.
Corn Bags on Ammunition Boxes.	Drag-Ropes. See following return.
Gun Tarpaulins.	Painted Covers for Harness.
Swingle Trees.	Couples for Traces.
Sheep Skins with Howitzers.	Swingle Trees.
Painted Covers for Harness.	Sheep Skins.
Leather Cartouches, except two per Battery.	Paper Cartridges.
Handscrew Jacks.	Grape Shot.
Portfire Clippers.	Flax.
Chests for Tools.	Tow.
Quadrants and Perpendicular.	Rasps, half-round.
Three of the Spherical Fuzes and Bags.	Diagonal Scales.
Spoke Shaves.	Copper Pincers.
Bick Irons.	Copper Salting Boxes.
Flax.	Wood Vices.
Tow.	All cut Spherical Fuzes and Bags.
Wooden Water-buckets, Do. Grease boxes, Hair Nose-bags, Tin Tube-boxes — To be replaced as per following return.	Carpenter's Tools.
	Cooper's Jointer Plane.
	Smith's Bellows, large.
	Do. Anvils, large.
	Do. Bick Irons.
	Stable Shovels
	Clouts, body and linch, Clout Nails — On the supposition of all Iron Axles.
	Painting Materials.
	Wooden Water-buckets — To be replaced as per following return.

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Articles of the Battering and Field Train Equipment recommended to be modified.

1. To substitute a Prolonge instead of Drag-ropes with Field Guns, each limber waggon, however, having two pieces of two-inch rope each, 6 yards long.

2. To substitute for the existing grease box with carriages, a tin grease box, of the pattern prepared in the Carriage Department.

3. To substitute a leather bucket for the wooden buckets hitherto used, and to have one with each carriage.

4. The Limber and Ammunition Waggon Covers to be of a simple construction, according to pattern in Carriage Department.

5. To have only one Spunge per Gun, and the wadhook to have a Spunge-head fitted at the other end; the spare Spunge-heads to be sent as usual.

6. To have a Lock with each Gun, as an additional resource for firing, but without diminution of the means of firing carried hitherto.*

7. The Lifting Jack to be of the pattern prepared in the Carriage Department.

8. The present tube boxes to be discontinued, and leather tube pockets substituted.

9. Each driver or mounted man to have a Cavalry corn bag on his saddle. the corn bags formerly carried on the ammunition bozes to be discontinued; these bags are exclusive of the corn sacks required per carriage.

10. A canvas nose bag to be substituted for the hair now used.

[*W.*] Is this right?

[*C.*] The Horses' Hair Nose-bag soon becomes dirty; if washed, wears out, and it is in truth an article of constant supply. It is believed that the canvas bag is both cheaper and more durable.

11. That, as already noticed in the body of the report, Drag-ropes with heavy Ordnance to be replaced by men's harness, which is further recommended to be made so as to be applicable to the strength of sixteen men, instead of twelve as hitherto.

12. As the word *Tarpaulin*, in the foregoing equipment, is only made use as signifying a cover or protection to the ammunition from the injuries of the weather, the Sub-Committee are of opinion, that the service would be benefited, by substituting the dyed Canvas, already approved of by a former Sub-Committee.

13. That in future equipments of Artillery, spare Harness should be allowed in the proportion per Field Battery, of 4 Horses Leading Harness, and 2 Horses Wheel Harness. That no spare Harness is necessary with Battering Train Equipments, as the whole of the allotted proportion of Harness can hardly, under any circumstances, be expected to be in use at the same time.

* See *ante* p. 202, note.

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14. That a spare Linch-pin and Washer, and also a Leather Bucket, be allowed to each Carriage.

15. That two Leather Cartouches be allowed per Field Battery, to be carried in the Store Waggon, in lieu of those hitherto allowed per Gun.

16. That the present stuffing of the ammunition boxes be discontinued.

17. That Blankets be in future issued, so as to allow on Field Service one Blanket for each Horse in Harness: the Driver's Blanket suffices for the Horse on which the man rides, but one is also required for the Off-Horse, and is necessary to protect the Horse from being galled by the Harness, which otherwise is the case, notwithstanding every precaution. But it appears to the Sub-Committee, that the Blankets now issued are unnecessarily large, and that a Blanket of $2\frac{1}{2}$ yards by $1\frac{1}{2}$ yards would be more convenient and less expensive.

18. The galling of Horses, both with Riding and Draught, is in a great measure owing to the weight of the Soldier's Saddle-bag, which, from the quantity of articles contained in the kit, becomes inconvenient both in weight and size.

19. The Sub-Committee, therefore, beg strongly to recommend that a diminution of the kit be made, so as to reduce the size of the Artilleryman's Knapsack to that of the Infantry Soldiers; and they consider that great good would accrue, if the Saddle-bags of the mounted men of the Artillery Service were made smaller than at present, and so shaped as to allow of their being easily carried by the men when dismounted, as is so frequently the case.

It appears to the Sub-Committee, that to obtain this desirable end, it is only necessary to reduce the kit of the mounted men, and that the Saddle-bags be made of the shape used in the Hussar Service, and that its material be Cloth or dyed Canvass, instead of Leather, as at present. If the dyed Canvass should prove as serviceable as there is reason to expect, it appears to the Sub-Committee, that the Oil Decks issued to all mounted men, might be entirely dispensed with.

20. In reference to the personal appointments of the mounted men, the Sub-Committee cannot help thinking, that the Drivers should be furnished with Cloaks similar to those allowed to Gunners of Horse Artillery, the Great Coats hitherto issued to the Drivers being very inferior in point of comfort. The Clothing and Arming of this valuable class of men has been already noticed.

The Sub-Committee, in closing their Report, have classed together some miscellaneous observations, which have either been omitted in their proper places, or have arisen from a review of the whole subject submitted to their consideration.

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Field Ordnance.

In considering the subject of Field Ordnanee, the Sub-Committee beg to express their opinion, that it would be for the benefit of the service that the following changes were made:—

1. That the charges for all Field Guns were reduced to one-fourth of the shot's nominal weight. This has become the more desirable, not only from the acknowledged strength and excellence of the powder used in His Majesty's Service, but from the late diminution of windage to one-tenth of an inch. Charges of one-fourth of the shot's weight, whilst fully equal to any ranges which can be required in the field, would render the action and recoil of the Guns in firing more moderate and easy to their carriages, occasioning in consequence less wear and tear, would produce more accurate firing, and also an economy of powder, which is now so well guarded in the boxes against deterioration, as to render an excess of charge from this idea by no means necessary.

It will be recollected, that one-third the shot's weight is allotted to Battering Guns, solely for the purpose of breaching, and not in reference to their ranges.

2. That in Howitzers for Field Services cast in future, their bores should correspond correctly with those of Guns of the same nominal Calibres.

This would render the 24-Pr. and 12-Pr. Howitzers available for ricochet firing, as well as for the application of red hot shot when circumstances might require it, as in the instance of burning buildings converted into temporary posts.

3. That henceforth round Shot, Spherical Case Shot, and common Shells, be cast correctly of the same diameter. This, it is considered, would be more simple than the trifling difference of diameter which at present exists, but of which the utility is not apparent.

(Note by the Editor.)

The enormous extent of the stock of Shot on hand, at the close of the last war, may be partly inferred from the fact that no less than 7,020 tons of it, nearly all serviceable, were ordered for sale by the Board of Ordnance, on one occasion, in March, 1822. 1,110 tons out of this large quantity was composed of shot of the smaller natures, from 12-Pr. downwards, and 2,350 tons of 24-Pr. shot. Such being the case, there were doubtless difficulties in at once carrying out the suggestions of the Committee for a revision of the Charges of Field Guns, and the assimilation of the diameters of ordnance of the same nominal calibre, and of the various species of projectiles used with those pieces. It is to be regretted, however, that these reforms have not been the subject of any systematic endeavours since. The charge of the 12-Pr. has been reduced to 3 lbs., and that of the 9-Pr. was reduced in 1844 to 2½ lbs.; but this is still ¼ lb. in excess of the quantity recommended by the Committee; and no authorized Tables of Ranges for this, the most universal Field Gun in the Service, for the reduced charge, have been promulgated down to the present time. The ranges originally established for a charge of 3 lbs. are still referred to, as approximately correct for the charge of 2½ lbs. This will surprise no one who reflects that no special Department of Instruction for Artillery Practice, such as the French *Ecole du tir*, exists in our Service, and consequently that the formation of Practice Tables is still left entirely to individual exertions, upon such data as personal enquiry may command. The calibre of the 12-Pr. Howitzer is still 4·580 inches; of the 12-Pr Gun 4·623 inches. The calibre of the 24-Pr. Howitzer is 5·720 inches; that of the 24-Pr. Gun 5·823

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inches. The calibre of the 32 Pr. Brass Howitzer is the same as that of the 32-Pr. Iron Carronade, namely, 6·250 inches, and that of the 32-Pr. Gun from 6·30 to 6·41 inches for different natures. In this last instance, therefore, we have a difference of more than *one-eighth* of an inch between the calibres of two pieces of the same denomination, and intended to fire the same projectiles.

With regard to the guages of the Shot and Shells, the differences are most perplexing. Monk's 56-Pr. is the only nature in which the Common Shell, the Shrapnel, and the solid Shot, have one and the same mean diameter. In the 42-Pr. the last is allowed a greater mean windage, or a lower mean guage, than the other two. In every other nature it has a less windage, or a higher mean guage. Where separate projectiles exist for Land and Sea Service, as in the 10-Inch and 8-Inch Hollow Shot Guns, they too have a different mean guage. It was not until 1843 that steps were taken to reduce the windage of Field Guns to the uniform value 0·10 inch. This was directed to be done by raising the Low Guage, a sufficient amount to leave that quantity as the difference between the mean of the High and Low Guages and the diameter of the Gun. The actual errors of casting in our shot are now reduced, through the exertions of the late and the present Inspectors of Artillery, within exceedingly small limits. Colonel CHALMERS, R.A., was so good, at the writer's request, as to cause, in August last, 30 shots to be taken indiscriminately from a pile of each of the undermentioned natures, and individually weighed and guaged. Lieutenant ROBERT W. HAIG, R.A., then undertook the somewhat troublesome task of calculating the probable deviation of any individual shot from the mean of the whole, or the average error of casting, with the following satisfactory results:—

Calibre.	*Mean weight of 30 shots, without bottoms.* lbs. oz. dr.	*Standard mean guage.* Inches.	*Mean diameter of 30 shots.* Inches.	*Average deviation of any single shot from the mean=E.* Inches.
32-Pr.	31 13 0	6·177	6·191	0·0033
24 ...	23 4 3	5·611	5·598	0·0052
18 ...	17 9 14	5·099	5·107	0·0048
12 ...	12 3 14	5·523	4·519	0·0035
9 ...	9 3 12	4·100	4·103	0·0033
6 ...	5 15 13	3·568	3·569	0·0033

Lieutenant HAIG made use of a formula usually adopted in similar calculations,

$$E^2 = \frac{\cdot 4549\ S\ (x-a)2}{n-1}$$

where a represents the arithmetical mean of all the measurements; $S\ (x-a)^2$ represents the sum of the squares of the differences between each single measurement and their mean a; and n represents the number of measurements. (See 8th Report of the Brit. Assoc.) Report on the Magnetic Isoclinal lines, &c., § III. This process is necessary if we wish to test the irregularities of any series of measurements, or observations, as the mean furnishes no clue to these. The exceedingly small amount of the apparent irregularity, indicates, what was indeed the fact, that a great proportion of the diameters were sensibly identical: the means of measurement by Calipers scarcely admits of appreciating differences in the third decimal.

The 32-Pr. Shot is the only nature at present tested by weight as well as diameter. The Shots are required to weigh not over 32 lbs., or under 31 lbs. 10 oz. The mean weights given above, appear to shew that great differences exist in the quality and specific gravity of the iron employed by the founders. As data of this kind are not generally accessible, although Gunnery, like every other scientific pursuit, requires all known sources of irregularity to be estimated, and if possible reduced to their lowest amount, before it can reach its greatest attainable precision, the *Editor* makes no apology for subjoining some further results.

Colonel WILLIAM B DUNDAS, the late Inspector of Artillery, caused a number of 32-Pr. Shot to be carefully guaged: 50 of date 1832, gave an average diameter of 6·162 inches, highest 6·18, lowest 6·15 inches; 50 of date 1835, gave mean diameter 6·157, highest 6·17, lowest 6·15 inches; 100 of date 1839, gave mean 6·159, highest 6·17, lowest 6·15 inches. We find above, in 1854, the mean of 30 Shots to be as high as 6·191 inches, the minimum of weight having been raised. The general result serves to shew, that so far as the windage of Guns is regulated by the necessary variations in the diameter of the projectiles, it may be brought within very narrow limits of uncertainty. It may also be remarked, that some improvement is easily attainable in the density of the Shot, and consequently in the ranges, none of the above weights come up to the mean specific gravity generally given for cast iron; and it is evident, that sometimes the Shot are notably under weight, the 24-Pr. above are an example. Previous to the sale of the large quantity of Shot referred to at the commencement of this note, Lieut.-Colonels Williamson, Sir Augustus Frazer, and Sir Alexander Dickson, were directed to inspect the piles, and set aside the most faulty Shot for the purpose of being disposed of. Lieut.-Colonel Williamson found the 24-Pr. Shot very uniform in size, most of them fitted the high guage with

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very great accuracy. Sir Augustus Frazer found the 68-Prs. in good order, but generally above the high guage of 7·90 inches. The 42-Prs. were found to be under the high guage of 6·78 inches. The 32-Prs. were found of proper guage, and in good order.

Sir Alexander Dickson found the 18-Prs. high, but very equal in size. The 12-Prs. were also very equal in size: out of 300 12-Prs., only one went through the low guage, all the rest were very equal. Out of a like number of 6-Pr. Shot, eight went through the low guage.

In 1833, the then Director of the Laboratory, Sir Augustus Frazer, directed 40 10-Inch Shells to be carefully weighed. The first 20, which were old ones, varied from 82 lbs. 10 oz. to 88 lbs. 10 oz., and averaged 85 lbs. 15 oz. 10 dr. The second 20 were better, they varied from 84 lbs. to 87 lbs. 2 oz., and averaged 85 lbs. 7 oz. 12 dr. (See further Captain Boxer's Treatise on Artillery, page 34.)

Rockets.

As it appears to the Sub-Committee that they ought not to leave the subject of Rockets altogether unnoticed, they beg to observe, without entering into the question of the propriety of a Corps used solely for the Rocket Service, that as this Corps cannot be in all places and situations where Rockets may be useful, it appears to be very desirable that the Artillery soldiers generally should be instructed, as a regular part of their duty, in the use of this arm, with regard to which there is at present a mystery. There is also apparently a great variety of natures of Rockets, with the proposed applications of which the Corps of Artillery is entirely unacquainted.

It is therefore much to be wished, that the natures and application of Rockets most suitable to field and bombarding operations should be ascertained by a course of experiments, and that regular instructions should be drawn up, and an exercise formed for the men, who, in the course of their duty, may be called upon to use these auxiliary weapons.

The Sub-Committee cannot but think that Rockets would be made more easily efficient, if the number of their varieties were reduced to two, or at most three natures for the field, and one or two natures for bombarding, and if the machinery used were as simple as possible, and the carriages as nearly assimilated as could be to those used for the transport of ammunition in the service generally.

Note.—It is a question for the highest authorities only, whether the country gains, or the service loses, most, by a system of secrecy in any professional detail. The Congreve Rocket is one of those subjects upon which much reserve has at all times been maintained; and its composition is to this day an absolute secret. This may have prevented improvements, and it has not prevented Foreign Powers from fabricating Rockets which they deem superior to it. In other respects the suggestions of the Committee have been carried out.—*Ed.*

The Sub-Committee, in concluding, beg to state, that although there are many points which, from experience, it has become advisable to alter or improve, they nevertheless feel themselves called upon to notice the very efficient state in which every equipment that has fallen under their examination, has been sent out of late years.

End of the Report.

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APPENDIX I.—Page 178.

Establishment of Royal Artillery, Corps of Royal Artillery Drivers, and Horses, for a Brigade of each of the following natures of Field Ordnance for Home and Foreign Service.

Royal Arsenal, February, 1807.

HOME SERVICE.

NATURE OF BRIGADES.	No. of Ordnance and Carriages.	Royal Artillery.					Corps of Royal Artillery Drivers.											
							Officers and Men.									Horses.		
		Captains.	Subalterns.	N.C. Officers.	Gunners.	Total.	Lieutenants.	Serjeants.	Corporals.	Trumpeters.	Shoeing-Smiths.	Carriage-Smiths.	Wheelers.	Collar-makers.	Drivers.	Total.	Riding.	Draught.	Total.
9 and 12-Pounder Brigade.																		
Officers and Men,	...	1	1	6	54	62	1	1	3	1	2	1	1	1	...	11	...	...	..
12 or 9-Pounders,	5	...	...	...	...	...	...	...	...	...	...	...	...	...	15	15	...	30	30
5½-Inch Howitzers Heavy,	1	...	...	...	...	...	...	...	...	...	...	...	...	...	3	3	...	6	6
Ammunition Limber { 12 or 9-Pounder,	5	...	...	...	...	...	...	...	...	...	...	...	...	...	10	10	...	20	20
Carriages or Cars, { 5½-Inch Howitzer,	1	...	...	...	...	...	...	...	...	...	...	...	...	...	2	2	...	4	4
Reserve Ditto, { 12 or 9-Pounder,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Reserve Ditto, { 5½-Inch Howitzer,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Spare Gun Carriage to carry spare Wheels, a Collar-maker, and a Wheeler, with Tools and Materials,	1	...	...	...	...	...	...	...	...	...	...	...	...	...	2	2	...	4	4
Camp Equipage Waggons,	1	...	...	...	...	...	...	...	...	...	...	...	...	...	2	2	...	4	4
Forge Cart,	1	...	...	...	...	...	...	...	...	...	...	...	...	...	2	2	...	4	4
Horses for Officers, N.C. Officers, &c.,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	5	5	10	...	10
Spare,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	4	4	...	8	8
Total,	15	1	1	6	54	62	1	1	3	1	2	1	1	1	45	56	10	80	90

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6-Pounder Heavy Brigade.																						
Officers and Men,	...	1	1	6	54	62	1	1	3	1	2	1	1	1	...	11	...	...	...	...	...	...
6-Pounders Heavy,	5	...	...	...	...	...	...	...	...	...	...	...	...	...	15	15	...	30	...	...	...	30
5½-Inch Howitzers Heavy,	1	...	...	...	...	...	...	...	...	...	...	...	...	...	3	3	...	6	...	...	...	6
Ammunition Cars, { 6-Pounders Heavy,	5	...	...	...	...	...	...	...	...	...	...	...	...	...	10	10	...	20	...	...	...	20
Ammunition Cars, { 5½-Inch Howitzers Heavy,	1	...	...	...	...	...	...	...	...	...	...	...	...	...	2	2	...	4	...	...	...	4
Spare Gun Carriage to carry spare Wheels, a Collar-maker, and a Wheeler, with Tools and Materials,	1	...	...	...	...	...	...	...	...	...	...	...	...	...	2	2	...	4	...	...	...	4
Camp Equipage Waggon,	1	...	...	...	...	...	...	...	...	...	...	...	...	...	2	2	...	4	...	...	...	4
Forge Cart,	1	...	...	...	...	...	...	...	...	...	...	...	...	...	2	2	...	4	...	...	...	4
Horses for Officers, N.C. Officers, and Artificers,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	5	5	10	...	...	...	...	10
Spare,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	4	4	...	8	...	...	...	8
Total,	15	1	1	6	54	62	1	1	3	1	2	1	1	1	45	56	10	80	90			
6-Pounder Light Brigade.																						
Officers and Men,	...	1	1	6	54	62	1	1	2	1	1	1	1	1	...	9	...	...	...	...	...	...
6-Pounders Light,	5	...	...	...	...	...	...	...	...	...	...	...	...	...	10	10	...	20	...	...	...	20
5½-Inch Howitzers Light,	1	...	...	...	...	...	...	...	...	...	...	...	...	...	2	2	...	4	...	...	...	4
Ammunition Cars, { 6-Pounders Light,	5	...	...	...	...	...	...	...	...	...	...	...	...	...	10	10	...	20	...	...	...	20
Ammunition Cars, { 5½-Inch Howitzers Light,	1	...	...	...	...	...	...	...	...	...	...	...	...	...	2	2	...	4	...	...	...	4
Spare Gun Carriage to carry spare Wheels, a Collar-maker, and a Wheeler, with Tools and Materials,	1	...	...	...	...	...	...	...	...	...	...	...	...	...	2	2	...	4	...	...	...	4
Camp Equipage Waggon,	1	...	...	...	...	...	...	...	...	...	...	...	...	...	2	2	...	4	...	...	...	4
Forge Cart,	1	...	...	...	...	...	...	...	...	...	...	...	...	...	2	2	...	4	...	...	...	4
Horses for Officers, N.C. Officers, and Artificers,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	4	4	8	...	...	...	...	8
Spare,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	4	4	...	7	...	...	...	7
Total,	15	1	1	6	54	62	1	1	2	1	1	1	1	1	38	47	8	67	75			

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APPENDIX I, *(continued.)*

Establishment of Royal Artillery, Corps of Royal Artillery Drivers, and Horses for a Brigade of each of the following natures of Field Ordnance for Home and Foreign Service.

Royal Arsenal, February, 1807.

FOREIGN SERVICE.

NATURE OF BRIGADES.		No. of Ordnance and Carriages.	Royal Artillery.					Corps of Royal Artillery Drivers.											
								Officers and Men.										Horses.	
			Captains.	Subalterns.	N.C. Officers.	Gunners.	Total.	Lieutenants.	Serjeants.	Corporals.	Trumpeters.	Shoeing-Smiths.	Carriage-Smiths.	Wheelers.	Collar-makers.	Drivers.	Total.	Riding.	Draught.	Total.
9 and 12-Pounder Brigade.	Officers and Men,	...	1	1	6	54	62	1	1	4	1	2	1	1	1	...	12	...	...	...
	12 or 9-Pounders,	5	...	...	...	...	...	...	...	...	...	...	...	...	...	15	15	...	30	30
	5½-Inch Howitzers Heavy,	1	...	...	...	...	...	...	...	...	...	...	...	...	...	3	3	...	6	6
	Ammunition Limber { 12 or 9-Pounder,	5	...	...	...	...	...	...	...	...	...	...	...	...	...	10	10	...	20	20
	Carriages or Cars, { 5½-Inch Howitzer,	1	...	...	...	...	...	...	...	...	...	...	...	...	...	2	2	...	4	4
	Reserve Ditto, { 12 or 9-Pounder,	5	...	...	...	...	...	...	...	...	...	...	...	...	...	10	10	...	20	20
	Reserve Ditto, { 5½-Inch Howitzer,	1	...	...	...	...	...	...	...	...	...	...	...	...	...	2	2	...	4	4
	Spare Gun Carriage to carry spare Wheels, a Collar-maker, and a Wheeler, with Tools and Materials,	1	...	...	...	...	...	...	...	...	...	...	...	...	...	2	2	...	4	4
	Camp Equipage Waggons,	2	...	...	...	...	...	...	...	...	...	...	...	...	...	4	4	...	8	8
	Forge Cart,	1	..	...	...	...	...	...	...	...	...	...	...	...	...	2	2	...	4	4
	Horses for Officers, N.C. Officers, &c.,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	6	6	12	...	12
	Spare,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	6	6	...	11	11
	Total,	22	1	1	6	54	62	1	1	4	1	2	1	1	1	62	74	12	111	123

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6-Pounder Heavy Brigade.	Officers and Men,	...	1	1	6	54	62	1	1	3	1	2	1	1	1	...	11	...	...	...
	6-Pounders Heavy,	5	...	...	...	...	...	...	...	...	...	...	...	...	...	15	15	...	30	30
	5½-Inch Howitzers Heavy,	1	...	...	...	...	..	...	...	...	...	...	...	...	...	3	3	...	6	6
	Ammunition Cars, 6-Pounders Heavy,	5	...	...	..	...	...	...	...	...	...	...	...	...	...	10	10	...	20	20
	Ammunition Cars, 5½-Inch Howitzers Heavy,	1	...	...	...	...	...	...	...	...	...	...	...	...	...	2	2	...	4	4
	Spare Gun Carriage to carry spare Wheels, a Collar-maker, and a Wheeler, with Tools and Materials,	1	...	...	...	...	...	...	...	...	...	...	...	...	...	2	2	...	4	4
	Camp Equipage Waggon,	2	...	...	...	...	...	...	...	...	...	...	...	...	...	4	4	...	8	8
	Forge Cart	1	...	...	...	...	...	...	...	...	...	...	...	...	...	2	2	...	4	4
	Horses for Officers, N.C. Officers, and Artificers,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	6	6	11	...	11
	Spare,	...	..	...	...	...	...	...	...	...	..	...	...	...	...	5	5	...	9	9
	Total,	16	1	1	6	54	62	1	1	3	1	2	1	1	1	49	60	11	85	96
6-Pounder Light Brigade.	Officers and Men,	...	1	1	6	54	62	1	1	2	1	2	1	1	1	...	10	...	...	...
	6-Pounders Light,	5	...	...	...	...	...	...	...	...	...	...	...	...	...	10	10	...	20	20
	5½-Inch Howitzers Light,	1	..	...	...	...	...	...	...	...	...	..	...	...	...	2	2	...	4	4
	Ammunition Cars, 6-Pounders Light,	5	...	...	...	...	...	...	...	...	...	...	...	...	...	10	10	...	20	20
	Ammunition Cars, 5½-Inch Howitzers Light,	1	...	..	...	...	...	...	...	...	...	...	...	...	...	2	2	...	4	4
	Spare Gun Carriage to carry spare Wheels, a Collar-maker, and a Wheeler, with Tools and Materials,	1	...	...	...	...	...	...	...	...	...	...	...	...	...	2	2	...	4	4
	Camp Equipage Waggon,	2	...	...	...	...	...	...	...	...	...	...	...	...	...	4	4	...	8	8
	Forge Cart	1	...	...	...	...	...	...	...	...	...	...	...	...	...	2	2	...	4	4
	Horses for Officers, N.C Officers, and Artificers,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	5	5	10	...	10
	Spare,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	4	4	...	7	7
	Total,	16	1	1	6	54	62	1	1	2	1	2	1	1	1	41	51	10	71	81

In August 1811, Major-General Farrington, who commanded the Artillery in Portugal, obtained the sanction of Lord Wellington to a scale of establishment of the Driver Corps for 9-Pounder Brigades, which exceeded the above by 1 Staff-Serjeant, 1 Serjeant, 2 Corporals, 1 Farrier, 2 Shoeing-Smiths, 1 Wheeler, 1 Collar-maker, 34 Drivers, 6 Riding Horses, 31 Draught Horses, and 10 Baggage Mules. A Store Cart was added; but the number of Reserve Ammunition Waggons was only two instead of six, making 19 instead of 22 Carriages for this establishment. Six more Drivers were added in January 1812. (See page 168)—*Ed.*

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APPENDIX I, *(continued.)*

Proposed Strength and Distribution of a Troop of Horse Artillery, consisting of Six Pieces of Ordnance for Foreign Service.

May 20th, 1807.

Carriages.		Staff-Serjeants.	Serjeants.	Corporals.	Bombardiers.	Gunners.	Drivers.	Farriers and Smiths.	Carriage-Smiths.	Shoeing-Smiths.	Collar-makers.	Wheelers.	Trumpeters.	Total.	Horses. Riding.	Draught.	Total.
5	6-Pounders, {Mounted.	...	2	3	5	30	15	...	...	...	...	...	...	55	40	30	70
	{On the Limbers,	...	...	...	...	10	...	...	...	...	...	...	...	10	...	...	...
5	Ammunition Waggons,	...	...	...	...	10	10	...	...	...	...	...	...	20	...	20	20
1	5½-Inch Howitzer, {Mounted,	...	1	...	1	6	3	...	...	...	...	...	...	11	8	6	14
	{On the Limbers,	...	...	...	...	2	...	...	...	...	...	...	...	2	...	...	...
1	Ammunition Waggon,	...	...	...	...	2	2	...	...	...	...	...	...	4	...	4	4
1	Spare Gun and Wheel Carriage,	...	...	...	...	...	2	..	...	...	...	...	...	2	...	4	4
4	Baggage Waggons,	...	...	...	...	...	8	...	...	...	...	...	...	8	...	12	12
1	Forge,	...	...	...	...	...	2	...	...	...	...	...	...	2	...	4	4
	Staff-Serjeants,	2	...	...	...	...	...	...	...	...	...	...	...	2	2	...	2
	Artificers, {Mounted,	...	...	...	...	...	...	1	...	1	...	...	1	3	3	...	3
	{Dismounted,	...	...	...	...	...	...	...	1	1	2	1	...	5	...	...	...
	Acting-Trumpeter,	...	..	...	...	1	...	...	...	...	...	...	...	1	1	...	1
	Rough Rider,	...	...	...	...	1	...	...	...	...	...	...	...	1	...	...	...
	Officer's Servants,	...	...	...	...	6	...	...	...	...	...	...	...	6	...	...	...
	Number required,	2	3	3	6	68	42	1	1	2	2	1	1	132	54	84	138
	Spare with the Troop,	...	...	...	...	10	5	...	...	...	...	...	...	15	...	...	...
	Ditto attached,	...	...	...	...	...	7	...	...	...	...	...	...	7	...	14	14
	Total detached with the Troop,	2	3	3	6	78	54	1	1	2	2	1	1	154	54	98	152
	At Head-Quarters,	...	...	...	...	2	6	...	...	...	...	...	...	8	2	10	12
18	Establishment,	2	3	3	6	80	60	1	1	2	2	1	1	162	56	108	164

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APPENDIX II.—Page 181—2.

Memorandum on the Embarkation of Ordnance Equipments, prepared in reference to the expedition to Portugal, by Colonel Sir Augustus S. Frazer, MSS.—Ed.

Note on Horsing Carriages.

December, 1826.

This subject is naturally capable of sub-division into the two distinctions of:—

1. Embarkation of Field Artillery, that is, of Field Pieces with their attendant Carriages, comprising the Ammunition allotted to each Piece, together with the Officers, Men, and Horses, attached to them.

2. The embarkation of Artillery Equipments, either of Field Pieces or of Battering Trains, where horses do not form part of the equipment, and where the men are not told off to the Field or other Batteries, but are merely sent in aid of the general equipment.

3. These distinctions are necessary to be made since the embarkation of Horses requires that vessels should be specially fitted up to receive them, and the capacity of the vessels in this respect is the governing principle on which the calculation of their Tonnage for Guns, Carriages, Stores, and Men, is founded.

4. This general principle is, that an allowance of 8 Horses for 100 Tons will ensure accommodation, that is Tonnage for the personal and material to which the Horses are applied, so that an adherence to this principle enables each vessel to be loaded with a complete portion of Field Artillery, and admits of filling up any superabundant Tonnage by such quantity of Reserve Ammunition or general Stores, as the varying capacity of each vessel will permit.

5. An adherence to this principle has the further advantage of keeping Men, Horses, and Carriages together, and under the close inspection of the Officers, so that whatever is loaded is complete and efficient so far as it goes, and the addition of Reserve Ammunition and general Stores, to whatever degree the vessel can receive them, also tends to the economy of the arrangement.

6. In preparing Transports then, it should in the first instance, be made known to the Transport Board, whether the vessels are meant to be Ordnance Horse Ships, or Ordnance Store Ships, with the distinct understanding, whether the Ordnance Horse Ships are intended to receive the Guns and Carriages to which the Horses are attached, if not, Ordnance Horse Ships are like other Transports, fitted for the reception of Cavalry, and require no Magazines nor attention to convenient stowage for Guns and Carriages.

7. On the Transports making Woolwich, the first object is, that the vessel be reported, her state as to preparation examined, and the

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Magazines to receive begun upon at once. This operation, which may be carried on simultaneously with clearing the vessel, being completed, the Horses should first be sent on board, then the Guns and Carriages, and lastly, the Reserve Ammunition—yet the order of embarking them, must in some degree depend upon circumstances.

8. This operation will demand more or less time according to the facilities afforded by the position and capacity of the vessel, and the time of day of her arrival, since neither Horses nor Powder can conveniently be embarked at night; but generally speaking, all vessels of 200 or 300 Tons, should be loaded in the course of a day from the time of their being reported off the Arsenal, at Woolwich.

9. It becomes necessary to consider some of the preliminary arrangements for the embarkation of any Ordnance Equipments, and the first enquiry is, "To whom shall the first communication of the orders of the Board of Ordnance be made?"

The natural arrangement in this respect, would seem to be to the Deputy Adjutant-General, Director-General, Superintendant of Ordnance Shipping, Storekeeper's Department, and other Departments in the Arsenal, especially the Carriage Department.

10. The next point is, "what communication should immediately take place between the Departments at Woolwich?"

The readiest way of forwarding the service would appear to be, that the Deputy Adjutant-General, Director-General, and Superintendant of Shipping, should immediately act in concert, that the embarkation may be considered, in a military point of view, so as always to attend to facility of disembarkation. This will determine what class of vessels is most desirable to be had, which should at once be communicated to the Transport Department, since, till this essential point is arranged, no detail for the embarkation can be drawn out. It is obvious, that the most perfect understanding and personal communication between the Superintendant of Ordnance Shipping, and Agent of Transports, is absolutely necessary to secure the proper appropriation of vessels.

11. The next consideration is, "What should be the outline of the Equipment of the Material of Artillery to be embarked?"

It is necessary that this point should in the first instance be divided, and no deviation be permitted at the moment of embarkation; it probably should be as follows:—

Field Pieces of all natures to be embarked with their attendant Carriages, and with the details of Ammunition and Stores, as recommended by the Committee of Revision. The Reserve Ammunition for Field Pieces, and the quantity of Small Arm Ammunition, will depend on the orders of the Board. The proportion of Stores should be for any period which the Board may direct, but according to the scale laid down by the Committee of Revision, in their contemplation of a six months' supply. A strict adherance to this outline would at once prevent difficulty or doubt.

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12. It is next necessary to be determined "By whom the Equipment should be embarked;" and here it is clear that the embarkation must mainly be made under the direction and superintendance of the Artillery Officer going in charge of the Equipment. Every Officer and man to be aiding and assisting in embarking that which will probably be landed by themselves alone without any assistance; but such additional working parties should, at all times, be employed in embarkations at Woolwich, as the state of the garrison will afford; and the greatest energy should always be used to complete each embarkation in the least space of time.

13. This will be attained by attention to the following details:—

Horses.

Should be put on board in the usual way, by being slung and lowered into the hold, either from the wharf, when the vessel is alongside, or from boats brought to the side of the ship; the Horses should be brought down to the wharf with bridles and head collars only.

Harness and Appointments, including Saddles and Bridles.

14. It is of course understood that the Harness and Appointments have been previously fitted to the Horses, it only remains therefore that the harness of each pair of draft horses, and the appointments of each riding horse be tied together with the man's forage cord, having marked upon it the name of the man, the Field Battery, and particular Gun to which he is attached.

When harness or appointments can be stowed in hogsheads or vats, which is very desirable, the contents to be marked on them.

Guns and Carriages.

15. These should be brought down to the point of embarkation, the Guns dismounted, Carriages taken to pieces, small articles tied together, or secured in such a way as not to be lost, and all laid together in readiness to be put on board. The Ammunition of the Carriages to be, in the first instance, sent on board in the boxes, but on getting on board put into the magazine.

Reserve Ammunition and General Stores.

16. These should also be laid down near the Guns and Carriages to be embarked in the same vessel, that it may be distinctly shewn what is to be put on board each ship.

All this has been more minutely detailed in a Book of Exercise, submitted for the approbation of His Grace the Master-General, in

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September, 1825, it having been the intention that the embarkation and disembarkation of Field Artillery should form part of the Instruction of Artillerymen.

Attention and Precaution on board the Ship.

17. The necessary men should be stationed in the hold, and between decks to receive and stow away Horses and Carriages; and all fires to be carefully put out before any Ammunition is sent on board. In the stowage of all Ammunition, as well as of all Stores generally, attention should be paid that, as much as possible, the marked sides of casks and boxes be kept in view, so that their contents may be known and got at with facility.

Embarkation of Battering Trains and Reserve Ammunition, as well as of General Stores for an Artillery Equipment, exclusive of Field Batteries.

18. In the assemblage of the various articles for embarkation, those for each ship should be placed together when practicable, and be embarked, as a general rule, in the reverse order of their being wanted when landed; each Gun on board being understood to be accompanied by a complete proportion of every requisite detail of Ammunition and Small Stores, for the number of rounds directed by the Board of Ordnance, and by such proportion of General Stores as may be directed, always keeping in view the Scale of Proportion recommended by the Committee of Revision, so that in all equipments there may be one uniform system.

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APPENDIX III.

Selection of Orders and Memoranda issued from the Office of the Deputy Adjutant-General of Artillery, in reference to the Expedition to Turkey, 1854.

(A.)

To accompany the Table of Ordnance No. 1, and the Drawings Nos. 2, 3, 4, and 5, shewing the proposed alterations and improvments in Battery Equipment, approved by the Master-General and Board's order, dated 22d January, 1844, M—32.

Note.—The items are here enumerated, but it has not been thought necessary to give the Tables or Drawings.—*Ed.*

Heavy Ordnance.

1. Table descriptive of Iron Ordnance to be used in the Armament of Works, Forts, Towers, and Sea Batteries, including the 56-Pr. (See Confidential Circular.—*Ed.*)

Platforms and Carriages.

2. Drawing of the Dwarf Wooden Traversing Platforms, (for the Bracket Carriage without Trucks.) Traversing Platforms and Garrison Carriages to be cast iron for Armament in the time of peace, with a proportion of wooden Gun Carriages, to be kept at every strong place in store, to be substituted upon the most exposed points on the prospect during war, of a regular attack.

Embrasures and Parapets.

3. Drawing, shewing the form and construction of the Embrasure proposed by Lieut.-Colonel Emmett.

The Genouillere of Embrasures for the Dwarf Traversing Platforms, will be 4 feet 3 inches high.

Shot Furnaces.

4. Drawing, shewing the construction of the Reverberatory Shot Furnace, which, after revision of those upon the same principle at Bermuda and St. Nicholas Island, has afforded satisfactory results under the Commanding Officers of Royal Artillery, and Royal Engineers at Malta.

This principle is the same as was favorably reported by the Committee on Battery Equipment. It may be enlarged for 4 rows of Shot as a single Furnace, or made double if required, and whenever it is much exposed to the weather, it should have a covering shed, as shewn in sketch No. 5.

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(B.)

Deputy Adjutant-General's Office,
Woolwich, 14th February, 1854.

Memoranda.

Captain Paynter's Company, with "A" Field Battery, Captain Fitzmayer's Company, with "B" Field Battery, and Captain Thomas's Company, with "E" Field Battery, to be completed to 170 Horses each, and the following detail to each Company, to be held in readiness for service, viz. :—

Two Captains, 3 Lieutenants, 1 Medical Officer, 15 N.C. Officers, 9 Artificers, 2 Trumpeters, 158 Gunners and Drivers, 4 9-Prs., 2 24-Pr. Howitzers, 6 9-Pr. Ammunition Waggons, 5 24-Pr. Howitzer Waggons, 1 Forge, 1 Store Limber Waggon, 1 Store Cart, 1 Spare Gun Carriage unhorsed.

Captain Cheetham's Company will be held in readiness for Foreign Service, in charge of an Infantry Ball Cartridge Brigade, viz. :—

Two Captains, 3 Subalterns, 14 N.C. Officers, 150 Gunners and Drivers, 18 Artificers, 2 Trumpeters, 200 Horses, 45 Ball Cartridge Waggons.

Waggons, { 36 Horsed, 2 Forges, 2 Store Limber Waggons,
9 unhorsed, 2 Store Carts.

The following arrangements are to be strictly attended to by the Troop and Field Batteries under orders for Active Service, as far as they apply to each branch of the Corps, viz. :—

1. Each Officer to be allowed to take 2 cwt. of Baggage into the Field.
2. Servants to be in uniform, and no livery of any kind to be taken.
3. Labels of basil leather to be fastened to all the Saddles, Bridles, Harness, &c., &c., previous to packing, on each of which is to be legibly written the name of the Officer, N C. Officer, Artificer, Driver or Trumpeter, to whom each separate part belongs, with the number of the Sub-division and nature of Carriage.
4. A Blanket, Haversack, and Canteen, to be issued to each Officer, N.C. Officer, Gunner and Driver, Artificer, and Trumpeter.
5. The Blankets of the Officers and mounted N.C. Officers and men to be carried under the Saddle.
6. The Blankets of the N.C. Officers and Gunners (dismounted) to be rolled on the top of the Knapsack, the Great Coat to be folded on the back of the Knapsack.

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7. The whole of the bags belonging to the N.C. Officers and men to be left in store at Woolwich.

8. The Knapsack belonging to the mounted N.C. Officers, Artificers, Trumpeters, and the Drivers, to be put into store, properly marked, and a Valise to be issued to each. Feb. 15.

Swords.—To A, B, and E, Field Batteries, each 15 N.C. Officers, 9 Artificers, 2 Trumpeters, 86 Gunners and Drivers. Total 112.

To Capt. Harison's Reserve Company, 14 N.C. Officers, 8 Artificers, 2 Trumpeters, 118 Gunners and Drivers. Total 143.

To Capt. Cheetham's Company, 14 N.C. Officers, 18 Artificers, 2 Trumpeters, 60 Gunners and Drivers. Total 94.

The men who are Drivers not to have Swords.

(Signed) H. PALLISER, Lieut.-Colonel,
Assistant Adjutant-General.
Feb. 16.

(C.)

Distribution of Camp Equipage, A, B, and E, Field Batteries.

Sub-division 1.	1st Captain's Tents, ...	2	5
	N.C. Officers and Men's Tents, . .	3	
Sub-division 2.	Lieutenant's Tent, ...	1	4
	N.C. Officers and Men's Tents, . .	3	
Sub-division 3.	Lieutenant's Tent, ...	1	5
	Guard's Tent, ...	1	
	N.C. Officers and Men's Tents, . .	3	
Sub-division 4.	Surgeon's Tent, ...	1	4
	N.C. Officer's and Men's Tents, . .	3	
Sub-division 5.	Lieutenant's Tent, ...	1	5
	Hospital Tent, ...	1	
	N.C. Officers and Men's Tents, . .	3	
Sub-division 6.	2nd Captain's Tent, ...	1	4
	N.C. Officers and Men's Tents, . .	3	
	Total, ...		27

(Signed JOHN ADYE,
Brigade-Major.

Woolwich, 3rd March, 1854.

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INSTRUCTIONS FOR THE CARE AND MANAGEMENT OF TROOP HORSES ON BOARD SHIP.

Deputy Adjutant-General's Office,
Woolwich, 27th February, 1854.

Memorandum.

Colonel Cator is requested to direct the accompanying instructions for the care and management of Troop Horses on Board Ship, to be attended to by the Officers in Command of Detachments, who will during the voyage make notes on these subjects, as well as on the adequacy of the fitments, breast and buttock boards, bails, &c., and on any other points they may consider useful for notice on future embarkations, and transmit them through the Commanding Officer to the Deputy Adjutant-General, at the termination of the voyage, for the information of His Lordship the Master-General.

(Signed.) H. D. ROSS,
Deputy Adjutant-General.

Ventilation.

Ventilation is of the utmost importance. The windsails must be kept down fore and aft, when the weather permits, and every means should be resorted to for obtaining good ventilation when the weather obliges the hatches to be closed.

Stalls.

The spare Stalls should be used for shifting horses in case of falls, kicks, and accidents in bad weather.

Mangers.

Mangers should be high enough to prevent the horses from swaying over in a heavy sea, or from attempting to leap over if frightened. Mangers to be well secured.

Slings.

Horses not to be slung in the first instance, and only when absolutely necessary; let them first get their sea legs, they then begin to weary and like the slings. Sling every alternate horse and change daily. Slings should be suspended from the deck beams; they should

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hang always three inches under the horses' bellies ; they soon learn to lie in them. Care should be taken that the slings do not injure the horse's sheath. When a horse is once slung, great care should be taken after removing the sling, as the animal is apt to fall down on losing the accustomed support.

Halters.

Look well to the Halters that they are good and strong—tie up tight in rough weather—slack in smooth.

In case of madness.

In case of madness the horse is pretty sure to die, therefore think only of protecting the others from his violence; bleed him till he falls—pull him out from among the others and let him take his chance.

Horses falling.

When a horse gets down have the bails up before he rises, or he may rick his loins.

The Watch, how employed.

The watch, (supposed to be on deck), to be always below with the horses, to prevent accidents, and to feed and water the horses; hand rub the legs and ears.

A Carpenter or Wheeler should be employed in keeping in order the stalls and fittings.

Diseases.

Inflamation and Congestion of the Lungs; Spasmodic Cholic; Constipation of the Bowels; Vertigo; and Staggers, are the most common, arising from insufficient ventilation, too large quantities of water given at once, and a want of attention to keep up the usual evacuation of the bowels by laxitive medicines.

Diet.

Bran Mashes not to be mixed with Oats, unless the Oats are first bruised.

Shoeing and care of feet.

The feet of every horse should be pared fully down to its proper size, and the sole and frog washed as often as water can be procured.

Protection.

To save the Sheep Skins, used to prevent injuries by contusion and friction, from prematurely wearing out, it is recommended that

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old sail cloths or sacking be placed under each portion of skin, which would render them more durable. An ample supply of bolsters for preventing partial injuries from Collars and Straddles, should be sent with every Troop and Battery.

(Signed) H. D. ROSS,
Deputy Adjutant-General.

Memorandum.

1. With reference to the Deputy Adjutant-General's Memorandum of 27th February, 1854, (on the subject of the treatment and care of Horses on board Ship), the Brigadier-General desires that each Officer of the Troop, Batteries, and Ball Cartridge Brigade, will make a Copy of the Instructions, and Officers Commanding Troops or Batteries, will report, through the Brigade-Major previous to embarkation, that this has been complied with.

2. Each Officer in command of a division on board ship will keep an accurate journal during the voyage of all casualties which may happen to men or horses, with the date, the precautions adopted, and the result. They will also make any suggestions as to the fittings for the horses, which may occur to them. A copy of this journal to be sent at the conclusion of the voyage to the Brigade-Major for the General's information.

3. As many wives and children will be left behind on embarkation, the attention of Officers in command of Troops and Companies is directed to page 163, Article 1, and to Form 95, Finance Regulations, in which the method of remitting money by Soldiers to their wives is provided for.

4. Officers Commanding Troops and Companies will give orders that the Senior Non-Commissioned Officers of each Sub-division be provided with a Canvass Bag, into which the Washers, Linchpins, Ties, &c., of the Sub-division are to be tied up on embarkation. This Bag, together with the Camp Kettles, Water Buckets, Spades, &c., of the Sub-division, will all be packed in a spare vat, which will be provided for the purpose.

5. Every harness vat of a Sub-division is to have painted on its head the letter of the Troop or Battery, the No. of the Sub-division, and the articles it is to contain.

6. Each Officer of Troop and Batteries is to have a copy of the distribution of his Troop or Battery; also, a copy of the detailed order of embarkation. The details of orders 5 and 6 can be obtained from the Brigade-Major.

7. As many of the Non-Commissioned Officers and Men may have some old Fatigue Clothing, which will be useful on the voyage, and as they will have no bags in which to carry these things on board, an empty Corn Sack of each Sub-division can be used for this purpose, in which each man's fatigue old clothing might be taken on board and then distributed.

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8. As there will be a great quantity of Forage in each Ship, it is very necessary that every precaution should be taken against fire. No lucifer match boxes are to be taken on board, or secreted in corners, and the Agent of each Transport is to be consulted as to the part of the Ship where smoking can be allowed.

By order.

(Signed) JOHN ADYE,
Brigade-Major.

Woolwich, 2nd March, 1854.

Detail of Staff.

Memorandum.

The accompanying statement shews the number of Clerks, Servants, Horses, &c., to be attached to the Head-Quarters and Divisional Staff of the Artillery Force, under orders for Service in the Mediterranean; the whole of the Non-Commissioned Officers, Artificers, Gunners and Drivers of the detail are to be mustered with Captain Barker's Company, 11th Battalion, and Captain Barker will draw from Store, and issue the necessary Camp Equipage for them.

Swords and Belts for these men to be supplied by the Field Batteries. (Signed) H. D. ROSS,

1st March, 1854. Deputy Adjutant-General.

Staff, Clerks, Servants, Horses, &c.

	Officers.	N.C. Officers.	Gunners & Drivers.	Horses.	Tents.	Swords.	Belts.	Blankets.	Canteens.	Haversacks.
Brigadier-General Commanding,	1	...	3	4	2	3	3	4	4	4
Brigade-Major,	1	...	2	3	1	2	2	3	3	3
Aide-de-Camp,	1	...	2	3	1	2	2	3	3	3
Acting Adjutant and Quarter-Master,	1	...	2	2	1	2	2	3	3	3
Clerks { Serjeant J. P. Martin, 7th Batt. ... J. Hendley, 12th ... }	...	2	...	...	1	2	2	2	2	2
For 2 Store Carts,	...	...	2	4	...	...	2	2	2	2
Surgeon,	1	...	2	2	1	2	2	3	3	3
Veterinary Surgeon,	1	...	2	2	1	2	2	3	3	3
Major Dickson's Servant,	...	...	1	...	...	1	1	1	1	1
Farrier,	...	1	...	1	...	1	1	1	1	1
Shoeing-Smith,	...	...	1	...	...	1	1	1	1	1
Forge,	...	...	1	2	1	...	...	1	1	1
Commissary Servant,	...	...	1	...	...	1	1	1	1	1
Lieut.-Colonel Dacres,	1	...	2	3	2	2	2	3	3	3
Acting Adjutant,	1	...	2	2	1	2	2	3	3	3
For Store Cart,	...	...	1	2	1	...	1	1	1	1
Lieut.-Colonel Lake,	1	...	2	3	2	2	2	3	3	3
Acting-Adjutant,	1	..	2	2	1	2	2	3	3	3
For Store Cart,	...	...	1	2	1	...	1	1	1	1
Total,	10	3	29	37	17	27	32	42	42	42

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Duties of Officers and Non-Commissioned Officers.

Memorandum.

Brigadier-General Cator begs to call the attention of the Field Officers and Captains Commanding Troops and Batteries, to the due responsibility of all Officers and N.C. Officers in their several gradations, and particularly to the duties of Subaltern Officers in charge of Divisions.

It is only by placing confidence in those, more or less, that in subordinate situations, that the Superior Officers can draw out their zeal and capabilities, and give themselves an opportunity of judging to what extent their confidence can be placed. It is of essential importance, that all Officers and N.C. Officers in charge of inferior parts of the service, should be made responsible to their superiors. The Subaltern Officers in charge of Divisions to their Captains, and the Captains to the Field Officers under whom they may be serving.

By the arrangements made in the Transports, there will be one Division, as near as possible, complete in each, it will then be the duty of these Officers to superintend most minutely the embarkation of their Divisions in all their parts—the same on disembarking, recording all casualties on their arrival at their destination.

No Officer will, on any account, leave their vessels without permission, nor quit their posts until all their charges are disembarked.

The Captains in charge of Troops and Batteries will superintend the whole, and see that the young Officers, unused to service, attend to their duties, and report accordingly. The Brigadier-General has the greatest confidence in the zeal, intelligence, and activity of the Officers under his command, and only begs to remind them, particularly with regard to the junior part of the service, that they are about to proceed on a service, where the eyes of their country will be upon them. He never can doubt their gallantry before the enemy, but this is only a small part of the duties they have to perform. They must give their incessant attention to the comfort and care of the Men, the condition of the Horses, and the safety and serviceable state of the Ammunition.

They will, by a proper attention to these duties, place themselves in a distinguished position, and by neglecting them forfeit that advantage.

By order of Brigadier-General Cator.

(Signed) JOHN ADYE,
Captain, Brigade-Major.

Woolwich, 6th March, 1854.

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EMBARKATION RETURNS.

Proposed Detailed Order of Embarkation of C Troop, Royal Horse Artillery, for the Mediterranean.

Troop.	No. of Division.	Officers.	Non-Commissioned Officers.	Gunners. (Including Officer's Servants and Batmen.)	Drivers	Trumpeters.	Artificers.*	Horses.				Carriages.					Harness Vats.	For Spare Ship.										
								Riding.	Spare Riding.	Draught.	Spare Draught.	Guns or Howitzers.	Ammunition Waggons.	Rocket Carriage & Forge.	Store Limber Waggon.	Spare Gun Carriage and Store Cart.		Officers.	N.C. Officers.	Trumpeters.	Gunners.	Drivers.	Shoeing-Smiths and Collar-makers.	Horses.		6-Pounder Waggon.	12-Pr. Howitzer Waggon.	Rocket Carriage and Store Cart.	Harness Vats.
																								Riding.	Draught.				
Spare Ship.	C.																												
C Troop, Royal Horse Artillery.	1	2	5	20	17	...	3	23	...	24	4	2 G	1	1 F	...	...	10	...	...	1	6	9	S-S C-M	2	16	1	...	R C S C	3
	2	2	4	20	17	...	3	21	...	24	6	2 H	2	...	...	...	10	...	1	...	6	7	...	1	14	...	2	...	3
	3	1	3	20	18	1	3	19	...	30	2	2 G	1	...	1	G C	10	1	2	...	7	7	...	4	14	2	...	...	3
	4	1	3	19	23	1	2	6	1	38	6	...	5	R C	...	S C	9	...	...	...	...	...	...	...	...	...	...	...	...

* Artificers.—Farriers, 1: Shoeing-Smiths, 4: Collar-makers, 4: Wheelers, 2.
For the Magazine.—Limber Boxes: Waggon Boxes: Rockets.
The Surgeon's Chest of Medical Stores—the Veterinary Surgeon and Artificer's Chests, to be stowed where they can be got at.

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Proposed detailed order of Embarkation of A, B, and E Field Batteries, Ball Cartridge Brigade, and Reserve Company, under orders for the Mediterranean.

Battery.	No. of Division.	Officers.	N.C. Officers.	Grs. (Including Offrs. Servs. & batmen.)	Drivers.	Trumpeters.	Artificers.‖	Horses. Riding.	Horses. Spare Riding.	Horses. Draught.	Horses. Spare Draught.	Carriages. Gun.	Carriages. How. & Rocket.	Carriages. Forge.	Carriages. Store L. Wagn.	Carriages. Store Cart.	Carriages. Amm. Waggon.	For Magazine. Limber Boxes.	For Magazine. Waggon Boxes.	Harness Vats.	For Spare Ship. N.C. Officers.	For Spare Ship. Gunners.	For Spare Ship. Drivers.	For Spare Ship. Artificers.	For Spare Ship. Horses. Riding.	For Spare Ship. Horses. Draught.	For Spare Ship. 9-Pr. Waggon.	For Spare Ship. 24-Pr. Howr.	For Spare Ship. Harness Vats.
A Field Battery	1	2	4	29	20	1	3	10	...	36	4	2	H	1	...	1	2	8	4	10	1	...	3	...	...	6	1	...	1
	2	2	4	28	23‡	...	3	6	4	40	2‡	...	2	...	...	...	4	12	8	11	1	...	3	...	...	6	...	1	1
	3	2	5	29	21	1	3	10	...	40	2	3*	1*	...	1	...	3	10	6	11	...	...	2	...	...	4	...	...	1
B Field Battery	1	2	4	29	20	1	3	10	...	36	4	2	H	1	...	1	2	8	4	10	1	...	3	...	...	6	1	...	1
	2	2	4	28	23‡	...	3	6	4	40	2‡	...	2	...	...	...	4	12	8	11	1	...	3	...	...	6	...	1	1
	3	2	5	29	21	1	3	10	...	40	2	3*	1*	...	1	...	3	10	6	11	...	...	2	...	...	4	...	...	1
E Field Battery	1	2	4	29	20	1	3	10	...	36	4	2	H	1	...	1	2	8	4	10	1	...	3	...	...	6	1	...	1
	2	2	4	28	22	...	2	6	4	40	...	...	2	...	...	...	4	12	8	11	1	...	3	...	...	6	..	1	1
	3	1	5	27	22	1	2	8	...	40	4	3*	1*	..	1	...	3	10	6	11	...	2	2	2	2	4	...	...	1
Spare Field Battery Ship. From A	...	...	2	...	8	...	...	...	...	16	...	...	...	...	...	...	2	4	8	3	...	...	...	...	...	...	..	...	...
Spare Field Battery Ship. From B	...	...	2	...	8	...	...	...	...	16	...	...	...	...	...	...	2	4	8	3	...	...	...	...	...	...	...	...	...
Spare Field Battery Ship. From E	...	...	2	2	8	...	2	2	...	16	...	...	...	...	...	...	2	4	8	3	...	...	...	...	...	...	...	...	...
Total Spare Ship.	...	1†	6	2	24	...	2	2	...	48	...	...	...	...	...	...	6	12	24	9	...	...	...	...	...	...	...	...	...
U Ball Cartridge Brigade.	1	2	3	15	23	...	5	6	...	44	2	...	...	1	...	1	12§	...	...	10	...	...	...	...	...	...	...	...	...
	2	1	4	15	22	1	4	5	...	42	2	...	...	...	1	...	12§	...	...	9	...	...	...	...	...	...	...	...	...
	3	1	3	15	22	1	5	5	...	42	2	..	...	1	...	...	12§	...	...	9	...	...	...	...	...	...	...	...	...
	4	1	4	15	23	...	4	4	2	44	...	...	...	...	1	1	9	...	...	9	...	...	...	...	...	...	...	...	...
Staff and Reserve Company.		15	16	141	5	2	11	32	...	10	...	...	...	1	...	4	...	...	...	...	...	...	...	...	...	...	...	...	...

‡ 2 Spare Draught Horses and 1 Driver from No. 3 Division. * 1 Spare Gun and 1 Rocket Carriage (not horsed.) † Lieut. De Haviland of the Reserve Company.
§ 3 not horsed in each ship. ‖ Artificers—Farriers, 7; Shoeing-Smiths, 25; Collar-Makers, 12; Wheelers, 12.

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EMBARKATIONS *(continued.)*

Memorandum for Captains of Batteries.

The Men for each Ship to be told off into Messes of 8, and into 3 watches.

On the arrival at the Dock-yard, the Divisions are to be drawn up opposite their Ships. The Gunners are at once to be marched on board and take off their kits, arms, &c., and hang them up in their proper places, take off coattees and chacos, and then come on shore. The Drivers will then do the same, and when all is ready, the unharnessing and packing will commence, and the embarkation of horses will be proceeded with.

No Officer, Non-Commissioned Officers or Men, are to leave the Dock-yard on any account.

A Guard to be told off for each Ship of 1 Non-Commissioned Officer and 6 Gunners, to furnish one Sentry on the Gangway, and another over the Water Tank on the main deck.

The Captains are to take care that the Men's Hair is cut according the Queen's Regulations.

The Ships allotted to each Battery are to be inspected by the Captains of Batteries, and Officers of Divisions, before the Horses are put on board, with the Wheelers, who are to examine the Battens in each Ship, and see that all the nails are counter-sunk.

(Signed) CHARLES BINGHAM,
Brigade-Major.

Memorandum of Returns required by Deputy Adjutant-General.

Monthly. *Of Royal Artillery*, to be dated on the 1st of each Month, and to shew the actual state of the Force on the previous day—a few days may be taken to complete this Return, but must not interfere with the date thereof.

Quarterly. 1st January. 1st April. 1st July. 1st October. *Of Regimental Defaulters*, in manuscript, one from each Troop, Battery, &c.,—same Form as Defaulter's Book, to be signed by Captains, countersigned by Divisional Commanding Officers, and sent through Brigadier-General.

Ditto. *Of Horses joined, transferred, or become non-effective.* Printed Forms to be rendered by Captains of Troops, Batteries, &c., countersigned by Divisional Commanding Officers, and sent through Brigadier-General.

Ditto. *Of Rough Riders and Artificers.* Printed Forms to be rendered by Captains of Field Batteries and Reserve only, countersigned by Divisional Commanding Officers, and sent through Brigadier-General.

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Ditto. *Of Sums received for Cast Horses.* Printed Forms from Troops, Batteries, &c., countersigned by Divisional Commanding Officers, and sent through Brigadier-General.

Ditto. *Of Sums received for Hides and Carcases of dead Horses.* Printed Forms from Troops, Batteries, &c., countersigned by Divisional Commanding Officers, and sent through Brigadier-General.

Ditto. *Of employed Men.* One from each Troop, Battery, &c. countersigned by Divisional Commanding Officers, and sent through Brigadier-General; for Form, vide Finance Regulations.

Half-Yearly. 1st January. 1st July. *Of Courts-Martial.* Printed Form from Troops, Batteries, &c., and countersigned by Divisional Commanding Officers, and sent through Brigadier-General.

Confidential Report. Full instructions for preparation of, will be sent.

Officers in receipt of Forage for private property Horses, including Staff, Horse Artillery, and Medical Department, General Return from Brigadier-General.

Memorandum respecting Reserves.

Woolwich, 24th April, 1854.

	Nature of Ordnance.	No. of Rounds per Gun taken with Troop and Batteries.	Reserve. No. of Rounds per Gun.	Reserve. When likely to sail, and in what Ship.	Remarks.
First Artillery Force	4 6-Pr. Guns.	231	300	Probably in Baalbec Steamer from Liverpool, about 28th April.	
	2 12-Pr. Howzrs.	238	300		
	12 9-Pr. Guns.	176	300		
	6 24-Pr. Howzrs.	174	300		
	Rockets.	216 6-Pr. Rockets. (Troop.) 100 12-Pr. Rockets with each Battery.			
	Stores.		In proportion to 300 Rounds per Gun.	Embarked in Suret sailing vessel, on the 21st April.	
Second Artillery Force.	4 6-Pr. Guns. 2 12-Pr. Howzrs. 12 9-Pr. Guns. 6 24-Pr. Howzrs.	The same as above.	The same as above.		The Reserve for Second Artillery Force is not yet reported complete by the Laboratory.
	Rockets.				
	Stores.				

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Harness.—100 Sets of Lead, and 80 Sets of Wheel, embarked in the Suret, 21st April.

In addition to the above, there are 3 9-Pr. Batteries to be sent to Malta, as a Depôt, complete with Guns, Carriages, Ammunition, Harness, &c., but when they are likely to be ready, or arrive, is uncertain.

There is also a 9-Pr. Battery complete, ordered as a Reserve for Gallipoli, but the same uncertainty exists respecting it.

GUNS OF POSITION.

Nature of Ordnance.	No. of Rounds ordered per Gun.	When likely to sail, and in what Ship.	Remarks.
10 32-Pr. Guns.	100	Reported to the Board as ready on the 11th April.	20 Shrapnel Case per Gun since added.
10 18-Pr. Guns.	100		
10 12-Pr Guns.	100		
10 8-Inch Howitzers.	90		Ditto.
10 32-Pr. Howitzers.	100	Unknown when likely to Sail.	
12 $4\frac{2}{5}$-Inch Mortars.	30		Ditto.

FIRST BATTERING TRAIN.

Nature of Ordnance.	No. of Rounds ordered per Gun.	When likely to sail, and in what Ship.	Remarks.
10 8-Inch Guns.	545	Two Steamers, Sidney and Harbinger, conveyed the Battering Train, on May, 1854.	
15 24-Pr. Guns.	545		
5 10-Inch Mortars.	330		
10 $5\frac{1}{2}$-Inch Mortars.	100		
24-Pr. Rockets.	96		
12-Pr. Fire Shell.	96		

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Ball Cartridge Ammunition. (From a Return by Mr. Rogers.)

Board's Order.	Quantity ordered.	Date of Issue.	Name of Vessel.	Place of Consignment.	Nature of Ammunition.				Remarks.
					Rifle Musquet, 1851. 2½ drams.	Line Pattern, 1842. 4½ drams.	Light Musquet, Ordnance Corps. 3½ drams.	Victoria Carbine. 2½ drams.	
21st February.	97,500	20th Feb.	With the Guards.	Malta.	97,500				
25th ...	1,000,000	31st March.	Orinoco, Medway, Trent.	Do.	125,000				
...	...	11th April.	Euxine.	Gallipoli.	500,000				
...	...	20th ...	Ripon.	Malta.	100,000				
3rd March,	900,000	20th March.	Do.	Do.	264,000	636,000			
13th ...	200,000	4th April.	Melbourne.	Do.	...		200,000		
23rd ...	50,000	From Gibraltar.		Do.	50,000				
25th ...	25,000	17th Feb.		Do.	25,000				
	100,000	31st March.	Mail Packet.	Do.	100,000				
25th ...	600,000	Will be ready in a few days						600,000	
8th April,	200,000	10th April.	Mail Packet.	Malta.	200,000				
11th ...	14,520,000	12th ...	Rajah.	Gallipoli.	200,000				
12th ...	200,000	13th ...	Andes.	Do.	200,000				
		18th ...	* Victoria.	Do.	766,500				
	17,892,500				2,628,000	636,000	200,000	600,000	

* Musket Blank Cartridge for exercise 200,600, shipped in Victoria.

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Lectures on the Science of Gunnery, delivered by Captain BOXER, R.A., *at the Royal Artillery Institution, on the 8th March, and 18th April*, 1854.

8th MARCH.

Having been requested to give an historical sketch of the Science of Artillery, it will be my object, this evening, to bring before your notice some of the most prominent points with reference to this interesting, and to us, important subject.

It would manifestly be impossible for me in one lecture to trace the progress which has been made in this Science in all its branches. I shall, therefore, this evening, confine myself to one of the most important considerations, viz.:—*The Force of Gunpowder*, hoping, on some future occasion, to continue the subject.

Gunnery was practised as an art for many years before any investigations were made as to the laws by which the various effects were governed, or in other words, before it was treated as a science: understanding the Science of Artillery to mean that exact, general, and speculative knowledge of the subject which can be embraced by intelligible principles, and not merely a knowledge of certain empirical rules.

It must be manifest to any intelligent person, that where the circumstances under which an art is practised are various, and where promptitude is of the utmost moment, a knowledge of *general principles* will be invaluable.

1st. In pointing out the proper course of action under peculiar and difficult circumstances.

2nd. In giving that confidence, which is of such vital importance to a military man.

Sir J. Herschel, in his introduction to Natural Philosophy states, in a general way, that this knowledge is useful.

1stly. In showing us how to avoid attempting impossibilities.

2ndly. In securing us from important mistakes in attempting what is, in itself possible, by means either inadequate, or actually opposed to the end in view.

3rdly. In enabling us to accomplish our ends in the easiest, shortest, most economical, and most effectual manner.

4thly. In inducing us to attempt, and enabling us to accomplish objects which, but for such knowledge, we should never have thought of undertaking.

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I am sure that every day's experience shows the truth of these remarks. We pass now to the subject which we propose to consider, viz. :—

The Force of Gunpowder.

By the Force of Gunpowder is meant the pressure, exerted by the generated gas at the moment of explosion : that is, when it occupies the space originally filled with the substance, and acted upon by the heat evolved in the chemical action.

Very vague notions were entertained for a long period, after the invention of gunpowder, not only with regard to the actual amount of force produced, but also as to the manner of its production. We cannot at all wonder at such being the case, for it was not until the middle of the eighteenth century, that Pneumatic Chemistry, or the Chemistry of the Gases, engaged the attention of philosophers. And although carbonic acid was discovered by Black in 1755, this part of the Science of Chemistry to which our subject more particularly belongs, was little understood until about 20 years afterwards, when Levoisier propounded his oxygen theory.

The first recorded experiment which at all bears upon the matter under consideration, is that made by Leuwenhoeck in 1693; the account of which may be found in the 3rd volume of the Philosophical Transactions. The object of the experiment was to determine to what extent gunpowder expanded itself upon ignition. Although Leuwenhoeck stated, that gunpowder fired, "expands 2080 times, or takes up so many times the space it did before," the experiment was far from showing such to be the case, and it is only interesting from its being the first that is recorded.

A few years afterwards, the celebrated mathematician John Bernouilli, proved by experiment, "that the air in gunpowder is not in its natural, but in a very compressed state;" and further, "that is was at least 100 times denser than natural air."

In 1707, Mr Francis Hauksbee, who was for some time Curator of Experiments to the Royal Society, communicated the following experiment, to determine the amount of permanent gas generated from fired gunpowder.

A glass tube, 36 inches long, and $\frac{3}{4}$ inch interior diameter, was fitted with a brass ferule, to which was attached an apparatus, containing a stop cock. A piece of cork, notched at its edge, was placed near the upper part of the tube, and the powder to be experimented upon was put into a small cavity at the top surface. The lower end of the tube being plunged in water, the air was withdrawn until the fluid had risen to a certain mark near the top. Upon exploding the gunpowder with a burning glass, the water suddenly descended, and after allowing it to remain for one hour, it was found that nearly one cubic inch of water had been

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removed, and upon taking into consideration the quantity, and the specific gravity of the substance, it appeared, that one cubic inch of gunpowder produced upon explosion about 200 cubic inches of gas: but it was also found, at the end of 18 days, that the water had risen nearly to its original position, and from this Hauksbee inferred, that the whole of the space first deserted was not filled by what he terms real air.

Daniel Bernouilli, in his *Hydrodinamica*, published in 1738, states, that the elastic force of the air generated from fired gunpowder must be upwards of ten thousand times that of natural air; this he concluded from the effect of the gunpowder upon a projectile in passing through the bore of a gun. He, moreover, assumed, that the elastic force of the air does not increase at the same rate as its density, but in a much higher ratio. Why he adopted this latter hypothesis was, in order to account for what he considered would otherwise be an absurdity. He reasons thus:—"if, as is commonly supposed the elastic force of the air is as its density, the air in powder must be 10,000 times denser than common air, and consequently the powder must be 10,000 times heavier than the atmosphere, but as it is not so much as 1000 times heavier, the elasticity of the air cannot be as its density." Forgetting that the elastic force of a gas is affected by heat, as well as by the proximity of its particles.

In 1742, Mr Benjamin Robins published a work entitled *New Principles of Gunnery*, which contains amongst other things relating to the Science of Artillery, an account of experiments made to determine *the Force of Gunpowder*. If we consider the absurd and erroneous notions that were generally entertained with regard to the Science of Artillery, before this eminent philosopher turned his attention to the subject, we cannot estimate his labours too highly.

Mr Robins' first object was to prove that gunpowder, upon being ignited, produced a permanent elastic fluid, both in the air and in a vacuum. This he showed to be the case in the air, by repeating Hauksbee's experiment, which has already been noticed, and in order to determine the effect of the explosion in a vacuum, a small quantity of gunpowder was ignited in a vessel, from which the air had been exhausted, when it was indicated by the mercurial gauge, that a permanent gas had been generated. It must be remarked, that this experiment had been made by Hauksbee in 1705, with a similar apparatus.

He then proceeded to find the amount of this permanent gas, which was done by noting the pressure exerted in the interior of a vessel of a *certain content*, from the gas produced by a certain *bulk of powder*, and after making some allowance for the temperature of the gas, he states, *that the proportion between the respective bulks of the powder, and the fluid produced therefrom, was* 1 *to* 244 *under the ordinary pressure of the atmosphere*. The next question had reference to the law existing between the elasticity and density of this fluid. Mr Robins showed, by exploding different quantities of powder in the exhausted receiver, that the pressures

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generated were directly as the quantities, or in other words, that the elasticity of the gas was directly as its density; and from this he inferred, that if the gas, instead of expanding when the powder was fired, had been confined in the same space which the substance filled before the explosion, it would have had, in that confined state, a degree of elasticity 244 times greater than that of common air, and this independently of the great augmentation the elasticity would receive from the action of the heat at that instant.

It now remained to estimate the effect of the heat that was evolved at the explosion.

Mr Robins did not attempt to determine the actual amount of this heat, but merely assumed it to be equal to that of red-hot iron; and by the following very ingenious experiment, he found that air would have its elasticity quadrupled by being raised to this temperature. A piece of musket barrel, 6 inches long, had one end closed, and the other drawn out conically, leaving an aperture of about $\frac{1}{8}$ of an inch. Upon raising this tube to a red heat, and closing the orifices, it was plunged into cold water with the aperture downwards, and allowed to remain until it was quite cold. When the stopper was removed, the fluid entered the barrel until the portion not filled with the water was to the whole content of the tube, as 1 to $4\frac{1}{11}$. He then reasons, that as air, and the fluid generated from fired gunpowder, appear to be equally affected by heat and cold—the effect of the heat at the moment of explosion was to increase the elasticity of the fluid upwards of fourfold.

So that taking into account both the density and the temperature of the gas, the pressure exerted by fired gunpowder before it dilated itself, was not less than 244 by $4\frac{1}{11}$, or in round numbers 1000 atmospheres; and Mr Robins also adds, that this force will be much augmented when large charges are employed.

Assuming the following hypothesis with regard to the action of a charge in a piece of ordnance, viz.:—

1stly. That the action of the powder on the projectile ceases as soon as it leaves the piece.

2ndly. That all the powder in the charge is fired, and converted into an elastic fluid, before the ball is sensibly moved from its place.

3rdly. That the law by which the force of the elastic fluid varies in this, that its intensity is directly as its density.

Mr Robins, by a simple geometrical process invented by Newton, deduced a fomula, by which the initial velocity of a shot could be determined when the first force of gunpowder is known. Having then computed the velocities of shot under various circumstances, he next determined the same from actual experiment, and finding that the computed and

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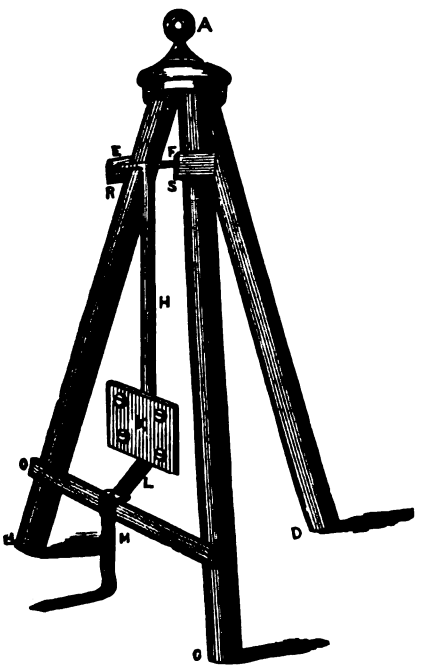
experimental velocities coincided in a remarkable manner, Mr Robins was confirmed in his opinion as to the truth of his hypothesis.

The means by which Mr Robins experimentally determined these velocities, deserves our especial notice, as the experimental data afforded by the apparatus which he invented and employed, forms the basis of the whole Science of Artillery: for without the aid of some such contrivance, although Gunnery would have been practised as an art, yet the real circumstances and principles which govern the motion of Military Projectiles, must have remained in obscurity.

Fig. 1.



The apparatus referred to consisted of a triangle *ABCD*, which supported a pendulum *H*, the axis *EF*, of which rested in sockets *R* and *S*, upon which it was made to vibrate with great freedom. A block of wood *K*, was screwed on to a plate of iron at the end of the bar *H*. At the bottom of the pendulum was fastened a narrow ribbon *LM*, which passed between the steel edges fastened to the brace *OP*.

In experimenting with this machine, Mr Robins first determined the weight of the pendulum, and the distances of the centres of gravity, and oscillation, from the axis of suspension, then by firing a ball of a certain weight at the block *K*, so as to impinge upon a certain point, he was enabled to determine the velocity with which it struck from the arc of recoil; this arc being measured by the ribbon *LM*.

Mr Robins, in his *New Principles of Gunnery*, overlooked a point of great importance in deducing the velocity of the ball from the arc of recoil of the pendulum. In determining the formula, he considered, that the effect of the impulse upon the mass of the pendulum, would be the same as if the same quantity of matter had been acted upon when free to move in a straight line. Now, this is only true, when the point struck is the centre of percussion, in which case there would be no force exerted upon the points of support; whereas, in Mr Robins' experiments, it was at a greater distance from the axis of suspension than the centre of percussion, and therefore the axis tended to turn backwards, and the arc of

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recoil was consequently affected, not only directly by the momentum of the bullet, but also by the resistance offered to this retrograde movement at the points of support *R* and *S*. The necessary correction was, however, made by Mr Robins, in the Philosophical Transactions of 1743.

About ten years after the publication of the *New Principles of Gunnery*, the celebrated Euler translated it into the German language, adding, at the same time, most copious remarks to our author's propositions. These remarks are of the greatest value, in pointing out upon mechanical principles, various defects in Mr Robins' hypothesis. Professor Euler first remarks upon Mr Robins' hypothesis with regard to the law of the elastic force of the vapour generated from fired gunpowder being as its density: and very justly observes that, although when this fluid occupies two, three, or four times less room, its elasticity may become two, three, or four times greater, it is no proof, that when it is condensed to the same degree as it must be in gunpowder, that this law of Boyle and Mariotte will still hold good. It may be observed, that the truth of this hypothesis will considerably affect Mr Robins' determination of the force of gunpowder from its effect upon a projectile in the bore of a gun.

He makes a similar remark also, with regard to the effect of the heat upon the elastic force, and states, that although from Mr Robins' experiment, air brought to the temperature of red-hot iron has its elasticity quadrupled, the same increase may not result when the air is compressed to any great extent.

In considering Mr Robins' method for determining the force of gunpowder from the velocity it produces upon a ball when fired from a piece under certain conditions, Professor Euler points out an important mechanical error, which, if Mr Robins' hypothesis be correct, would make the force of gunpowder much greater than what he assumed it to be.

In Mr Robins' investigation of the formula, no account was taken of the motion of the generated fluid during the passage of the ball through the bore of the piece, and the whole elastic force of the gunpowder was supposed to act upon the projectile. But this evidently cannot be the case, for a considerable amount of this force must be expended upon the vapour, and gas, that is generated at the explosion of the charge. In fact, if we take the gas to be of equal density throughout the bore, then will the centre of gravity of this gas move with one-half the velocity of the projectile, and if the charge be half the weight of ball, one-fifth of the whole momentum that is generated by the elastic force of the gas, during the passage of the ball through the bore, will be that due to the mass of the powder.

Now, as Mr Robins only considered the motion of the projectile, a less force was necessary to account for its velocity, than if the motion of the powder were taken into consideration; and in his formula, if the weight of the ball be taken equal to 0, there will be no obstruction to the move-

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ment of the gas, and its velocity will come out infinite, which at once shows the fallacy of the principle upon which it was determined.

Professor Euler also mentions other circumstances which Mr Robins has omitted to take into account, viz.:—the loss of force by windage—the resistance of the air in the bore of the gun—the friction of the ball against the sides of the bore, and the fact, that the charge is not wholly converted into gas before the ball has sensibly moved from its position: to each of which he endeavoured to assign a proper value, displaying in the several investigations the greatest ingenuity, and the most profound mathematical knowledge; and there can be little doubt, that had this celebrated philosopher had sufficient experimental data afforded him, he would have perfected those principles which Mr Robins had in part discovered.

Although Mr Robins' experiments were repeated and extended in Germany, Italy, and France, soon after the publication of the *New Principles of Gunnery*, very little progress was made in the science until 1775, when Dr Hutton, in conjunction with several Officers of Artillery, carried on a course of experiments, which were made with larger pieces than had been hitherto used for the purpose.

An account of these experiments was published in the Philosophical Transactions of 1778, and although they did little more than confirm the truth of Mr Robins' *principles*, they are exceedingly valuable, from the known ability of this eminent mathematician, for superintending experiments, requiring, at the same time, so much care and general scientific knowledge; *for it must be remarked, that experiments made for the purpose of establishing principles, whatever the subject may be, are worse than useless, unless a proper course of action be adopted and carried out, for they will tend rather to propagate error, than to establish truth.*

The experiments of Dr Hutton, which bear more immediately upon the subject under consideration, are those which had reference to the firing of gunpowder, and the loss of force by windage.

1stly. It was found that gunpowder fires almost instantaneously.

2ndly. That a considerable amount of the effect of the generated gas upon the bullet is lost by windage.

After making the necessary corrections in Mr Robins' formula for determining the force of gunpowder from the velocity of the shot, Dr Hutton found that the initial force of fired gunpowder must be at least 2000 atmospheres; it must be remarked, however, that the same law was taken with regard to effect of the density of the gas upon its elasticity.

Sir Benjamin Thompson (more generally known as Count Rumford, the latter title being conferred upon him by the King of Bavaria) instituted a very considerable course of experiments upon the force of fired gunpowder in 1792 and 1793, and although his deductions therefrom are

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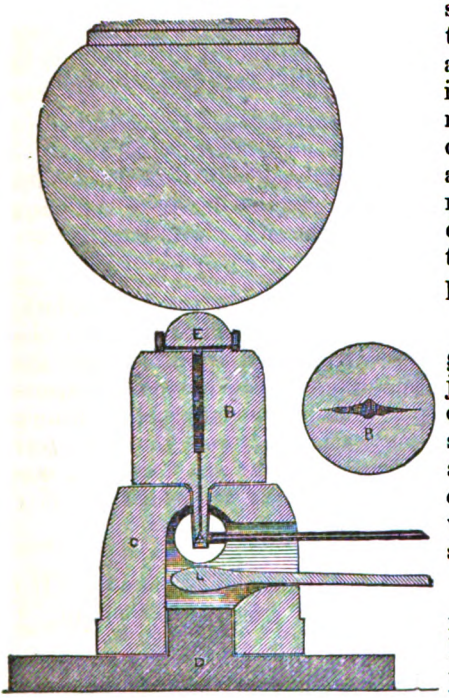
quite valueless in themselves, they serve to illustrate some intersting and important points with regard to the destructive effect of this propelling agent.

The plan which Count Rumford adopted was totally different from any which had been before employed, his object being to ascertain the force from actual measurement, in a direct and decisive experiment; for, as he truly observes, this force, so far from being known, had hitherto been rather guessed at.

Fig. 2.



The apparatus consisted of a short barrel *B* of the best iron, the diameter of the bore was $\frac{1}{4}$ of an inch, and of the exterior $2\frac{3}{4}$ inches, so that the thickness of metal was $1\frac{1}{4}$ inches: the length of the bore was 2·15 inches, and at the end of it was made a very narrow tube ·07 of an inch in diameter, and 1·715 inch long, this tube was continued into a projection *A* made in the barrel.

The barrel rested upon a gun metal support *C*, the projection *A* passing through an opening at the top into a hollow space, as shown in Fig. 2. The above support rested upon a circular plate of iron *D*, which was fixed upon a large block of stone.

In order to confine the generated gas, a stopper of prepared leather, well greased, was first put into the bore at the top, and exactly fitting it; a hardened steel hemisphere *E* was then placed over the bore, and upon this rested the weight that confined the gas.

The powder in the barrel was ignited by heating the projection *A* by means of a red-hot ball, which was passed through an opening in the support *C*, and kept in its position by the lever *L*. The content of the bore was one-tenth of a cubic inch, and the quantity of fine grain powder it would hold was 28 grains.

In the second experiment which was made with this apparatus, the bore was completely filled with powder, and a 24-pr. brass gun, weighing 8081 lbs., was placed upon the hemisphere to confine the gas, and the following was the result in Count Rumford's own words:—

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"I should be afraid to relate the result of this experiment, had I not the most indisputable evidence to produce in support of the facts. This inconsiderable quantity of gunpowder, when it was set on fire by the application of the red hot ball to the vent tube, exploded with such inconceivable force as to burst the barrel asunder in which it was confined, notwithstanding its enormous strength, and with such a loud report as to alarm the whole neighbourhood. It is impossible to describe the surprise of those who were spectators of this phenomenon; they literally turned pale with affright and astonishment, and it was some time before they could recover themselves.

"The barrel was not only completely burst asunder, but the two halves of it were thrown upon the ground in different directions: one of them fell close to my feet as I was standing near the machinery to observe more accurately the result of the experiment."

Count Rumford endeavoured to deduce the amount of force which must have been exerted to have produced this result in the following manner:—

He caused a portion of the broken barrel to be cut into pieces, 2 inches in length, and about $\frac{1}{8}$ of an inch square in the direction of its length, with a fine saw, the centre portions were then rounded in a lathe to a definite size. His object was to determine what amount of pressure was necessary to tear these bars asunder, and he found, by taking into account the size of the bars, and their breaking weights, that it would require a a force of 63,173 lbs. to tear asunder a portion of iron of 1 inch sectional area, and of the same strength as that of which the barrel was composed.

Now the area of the fracture of the barrel used in the experiment was $6\frac{1}{2}$ superficial inches, and Count Rumford therefore considered that the gunpowder must have exerted a pressure of 63,173 lbs. $\times 6\frac{1}{2}$, or 410,624$\frac{1}{2}$ lbs., and this turned into atmospheres, gives 54,750 atmospheres for the measure of the force which must have been exerted by the elastic fluid in bursting the barrel; but he considered, that even this enormous force fell short of the real initial force, for he thought that the barrel was in all probability fractured before the generated fluid had exerted all its force.

Before proceeding to give an account of some other experiments which were made under Count Rumford's directions, it will be as well to point out the fallacy of his deductions from the one already mentioned.

If we consider the nature of the action which takes place upon the ignition of gunpowder, it will become evident that the effect which is there produced, is not merely that of an ordinary pressure steadily applied, but rather the effect which would result from a body in motion coming in contact with a body at rest, or in other words, be similar to a blow. For in the decomposition of gunpowder by heat, there is brought about a

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sudden re-arrangement of the elements contained in the substance from the action of chemical affinity under certain conditions, and in this re-arrangement there must necessarily be motion in the particles. Now by a fundamental principle of mechanics, in order to bring these particles to a state of quiescence, a certain amount of "*work*" must be done upon them, or in other words, a resistance must be offered to their motion through a *certain distance*, so that even if the gunpowder has been in a solid form completely filling the vessel, there must have been a certain amount of "*work*" done upon the material of which the barrel was composed over and above the pressure due to the repulsive force existing between the particles of the fluid, or in other words, to the elasticity of the gas.

But the powder in the interior of the barrel in Count Rumford's experiment was in the form of grains, and therefore did not completely fill the bore, consequently there must have been motion in the particles, due not only to the above action, but also that due to the elasticity of the fluid.

Moreover, from the great violence of the explosion, the destructive effect was much augmented, for *time* was not given for the effect of the action to be distributed through the substance of the iron, so that in all probability the particles of the material at the surface of the bore were permanently separated in the first instance, and the rending was then continued by degrees through the whole thickness of the barrel. Also, from the fact of the two pieces being thrown directly to the ground on each side, it is evident that the barrel was torn asunder from end to end, instead of separating through the whole section at the same moment. Both of which circumstances, independently of the nature of the force, would materially affect the correctness of Count Rumford's computation as to the force of fired gunpowder.

Count Rumford's next object was, to determine whether Mr Robins' hypothesis with regard to the ratio which existed between the elastic force of the fluid and its density was correct.

A similar apparatus was used for this purpose, and the elastic force was measured by the weight which the generated gas was just able to move.

The content of the barrel being accurately determined, certain quantities of gunpowder bearing a particular ratio to the whole content of the bore were placed in, and the generated gas was confined by the application of certain weights to the steel hemisphere.

After making a great number of experiments, a curve was drawn from the data afforded by the most satisfactory ones, in the following manner:—

From the point *A* (Fig. 3) on the line *AB*, were set off distances representing the densities of the generated gas, and the corresponding elasticities, as determined by experiment, were then drawn at right angles

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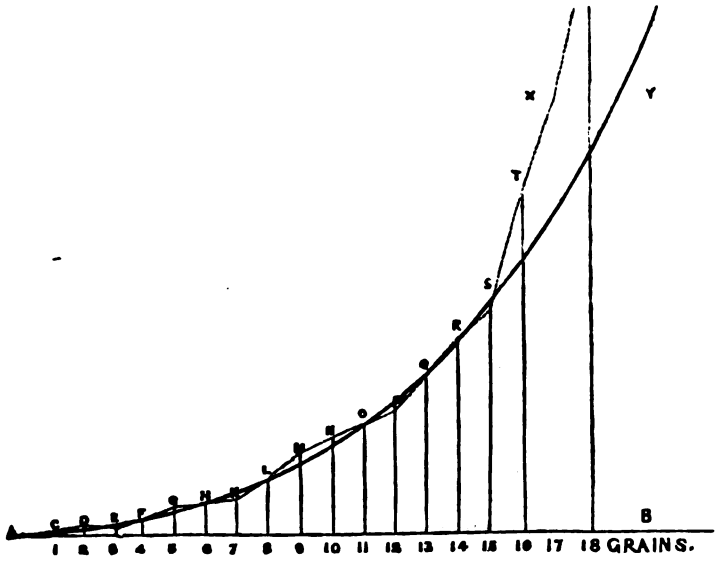
to this line, and through the points *C, D, E, F, G,* &c. the curve was drawn.

Fig. 3.



Count Rumford then proceeded to determine a general formula to express the relation existing between the density and the elasticity of the gas, and by taking $1{\cdot}141y$ equal to the elasticity in atmospheres, and x equal to the density of the fluid, 1000 being the density when the gas filled the space originally occupied by the powder, the equation $y=x^{1+{\cdot}0004x}$ was found to give results nearest to those found from experiment. And the curve AY, which is constructed from the above formula, serves to give a clear and satisfactory idea of the supposed law, as it was considered that the irregularities in the line AX were owing to errors in the experiments.

But upon taking the elasticity of the gas as 1000, and computing its elasticity by this formula, it appears that the force of gunpowder is only 29,178 atmospheres, and from the circumstances of the bursting of the barrel, together with the form of the curve AX, Count Rumford imagined that this formula would not correctly express the required relation when the density of the gas was very high, and he therefore selected an experiment, which appeared to show the ratio under circumstances the most favourable to the development of the force, and from it he obtained a formula, which gave the elasticity equal to 101,921 atmospheres when the density was 1000, and this he considered was the initial force of fired gunpowder.

We perceive at once, that the deduction arrived at by Count Rumford from the above experiments, were obtained upon most erroneous mechanical

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principles, for the movement of the weight was not only affected by the pressure of the elastic fluid, but also to a very great extent by the momentum of the particles of the fluid, as it is clear that the velocity of these particles must have been very considerable before they came in contact with the opposing body; and, although in all probability the law of Boyle and Marriott does not hold good in the case of a gas very highly condensed, it is quite clear that Count Rumford's formula does not show the ratio then existing, although his experiments to a certain extent indicate that the elasticities do not increase in the same ratio as the densities, but in a higher ratio.

In order to account for the supposed enormous force of fired gunpowder, Count Rumford had recourse to a most curious hypothesis, viz.: that this force was due to the water contained in the gunpowder being acted upon by the heat, evolved in the chemical action, and at the same time, assumed a most absurd hypothesis with regard to the effect of heat upon the elasticity of steam, viz. that from 212° Fah., its elasticity would be doubled by each increase of 30° Fah. By this law, steam raised to 10,000 Fah., would have an elasticity of 100,000,000 atmospheres.

However, in some supplementary observations made upon this subject, he considered that this law only existed when the steam was in contact with water, and he endeavoured to account for the force by, 1st, Supposing that the heat, which had been assumed by Mr Robins, was far less than that which is actually evolved upon the explosion of gunpowder; and 2nd, He assumed that the generated gas had its elasticity doubled for every additional 437° Fah., and by this hypothesis, if heat be taken as 3996° Fah., the elasticity would become equal to 128,000 atmospheres. It is needless to say that this law is altogether erroneous.

Since the discovery of the law with regard to the effect of temperature upon the volume of gases under the same pressure, by Gay Lussac, namely, that the volume of a gas will increase by equal increments, for equal increments of temperature; and further, that the volume will be enlarged at the rate of about $\frac{1}{480}$th part of the volume at 32° Fah. for every degree of Fahrenheit; another method, but similar in principle to Mr Robins', has been adopted to discover the force of fired gunpowder. It consists firstly, in determining the amount of generated gas either by direct experiment, or by assuming an hypothesis with regard to the decomposition; and secondly, in finding the effect of the heat evolved by the chemical action according to the above law.

That eminent chemist, Gay Lussac, upon a most careful analysis of the gaseous products of fired gunpowder, found that they consisted of carbonic acid, nitrogen, and a small quantity of other gases; and from this, as well as from the fact, that the solid residue is principally sulphide of potassium, it would appear that, under the circumstances attending the explosion of ordinary gunpowder, the oxygen in the saltpetre, both from the nitric acid and the potassa, combines with the carbon to form carbonic acid, thereby

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setting free the nitrogen, and that the sulphur combines with the potassium to form sulphide of potassium.

Now, if we assume this hypothesis with regard to the decomposition, we shall find that the proportions of the ingredients which are used in the manufacture of the service gunpowder, are as nearly as possible what they should be, in order to give the proper result, for instance according to this hypothesis,

$$KO,NO_5+S+3C=N+KS+3CO_2$$

and by taking the equivalents, the proportions of the ingredients will be 74·85 saltpetre, 11·84 sulphur, and 13·31 carbon, whereas the proportions in gunpowder are 75 saltpetre, 10 sulphur, and 15 charcoal; the charcoal, however, is not pure carbon, but contains a certain proportion of both oxygen and hydrogen, and therefore we may consider the two compositions as almost identical.

The first question then is, that with such a composition what will be the resulting quantities of gaseous products, when the decomposition takes place as above? they will be found to be for every 900 parts of gunpowder, 93·2 parts of nitrogen, and 439·4 parts of carbonic acid, and by taking the specific gravities of the gunpowder and the two gases, it appears that for every cubic foot of gunpowder there will be 317·4 cubic feet of permanent gas formed by the decomposition.

The second question is—What will be the amount of heat evolved by the chemical action; or, in other words, what will be the temperature of the resulting gases at the moment of explosion?

Great differences of opinions have existed, and do still exist, with reference to this point. Gay Lussac considered it to be 1800° Fah., while Saluces estimated it as high as 4352° Fah. The latter philosopher endeavoured to determine the temperature by the effect of the evolved heat upon different metals, now in order that a correct result may be arrived at by this method certain precautions must be taken, firstly, the substance acted upon must not be affected chemically by the generated gas and vapours, or if so acted upon, it must be enveloped in a material not so affected; and secondly, the heat must be applied for a sufficient length of time, to cause an effect which may be measured by some thermometer scale; for instance, suppose we wish to show the heat by the effect it will have in bringing certain metals to a fluid state, then, as a considerable quantity of heat will be absorbed in the operation, a sufficient amount may not be given unless time is allowed, although the heat in itself may be very intense, and not only so, but with different materials, variable quantities of heat are required to bring them to the same temperature.

Now it is almost certain that the temperature of the gas, at the moment of the explosion of the gunpowder, is not under 3000° Fah., and if we assume it to be so, and estimate the effect of this temperature upon the volume of the permanent gas by Gay Lussac's law, we shall find the

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volume before mentioned, viz. 317·4 increased in bulk nearly 7 times, or the one volume of gunpowder to become 2154 volumes of gas under the ordinary pressure of the atmosphere. But we have taken no account as yet of the vapour of the sulphide of potassium, and of the moisture which is contained in small quantities in all gunpowder, nor can we with our present knowledge arrive at any satisfactory conclusion with regard to this point; there can be no doubt, however, that it will very materially affect the solution of the problem by this method. But granting that we could determine with accuracy the volume which the resulting gases and vapours would occupy under the ordinary pressure of the atmosphere, when, at a temperature equal to that which results at the moment of explosion, it would still be necessary to know, firstly, whether gases condensed in so high a degree followed Boyle's and Marriotte's law, and secondly, whether Gay Lussac's law would hold good with gas raised to this temperature. In all probability these laws would not be observed under the circumstances. From these few remarks, it will be seen, we imagine, that with our present knowledge, no correct solution of our problem can be effected by this method.

Now, although our subject has engaged the attention of the most eminent philosophers, great uncertainty still exists not only with regard to the initial force of fired gunpowder, but also with reference to the law of the elasticity of the products when occupying different portions of the bore of a gun; and we may observe that the latter point is of equal importance with the former, for in solving questions in gunnery, it is necessary to know not merely the statical pressure exerted in the first instance, but also the "work" which is done by the charge under various circumstances, and the ratio existing between the force and the density of the gas is a necessary element in determining the amount of "work."

We imagine that much might be done towards obtaining a knowledge of these two interesting and important points by careful and extensive experiments with the gun and ballistic pendulum, by employing guns of different lengths under a variety of circumstances.

From these experiments sufficient data might be afforded to be applied in a general formula determined upon known mechanical principles. Surely then it is for us who are the most interested in the question, to endeavour to arrive at a more satisfactory solution of the problem, and I think we may reasonably expect that this Institution will be the means of concentrating our energies upon such professional subjects—the result of which will be not merely to establish our name as a scientific corps, but what is of much more consequence to increase the importance of that arm of the service to which we belong, for we may take it as a general truth, that where certain effects are required, a knowledge of the general principles which govern those effects is absolutely necessary to accomplish *with certainty* the end in view; and so far from scientific acquirements being detrimental to the efficiency of an Artillery Officer, they will elicit that

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interest in his profession which is, as it were, the main-spring of usefulness.

Feeling as I do the importance of a sound professional knowledge, I trust that the principal object of this Institution will be to advance that science upon which the perfection of the art of Artillery so much depends.

It is far from my purpose to attempt to underrate the value of knowledge, whatever may be the subjects involved; but a certain description of knowledge is necessary to the usefulness of particular classes, and the very existence of distinct professions shows this to be a generally admitted fact; and there can be little doubt, that if the system which has been so successfully applied in the arts, viz. "The Division of Labour" had not been adopted in the Sciences generally, we should, at the present moment, be unacquainted with those wonderful laws of nature, the knowledge of which has benefited the human race in so high a degree.

Now, the Science of Artillery includes so many of those divisions of general knowledge which have been classed as distinct sciences, that an Officer thoroughly acquainted with his profession will not only be eminently useful in his official capacity, and be entitled to the honourable denomination of a man of science, but will be fully qualified and peculiarly fitted for the performance of important duties not immediately connected with his profession.

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Second Lecture.

18th APRIL.

On the last occasion I had the pleasure of addressing you, I endeavoured to trace the progress which has been made in the Science of Artillery, with regard to one of the most important points, namely, *The Force of Gunpowder.*

I then pointed out that although experiments were made by Leuwenhoeck, Bernouilli, and Hauksbee, in 1693, 1700, and 1707, it was not until 1740, when Mr Robins took up the subject, that any important progress was made towards obtaining a knowledge of this branch of the science.

This distinguished philosopher investigated the subject as follows:—

Firstly, he determined from experiment the amount of permanent gas produced from a certain bulk of powder.

Secondly, he assumed a certain amount of heat to be evolved by the chemical action; and

Thirdly, he determined the effect of this heat upon air, and assumed it to be the same upon the generated gas.

By this process Mr Robins determined the force of gunpowder to be 1000 atmospheres.

In order to test the accuracy of this assumption, for after all it was but an assumption, he adopted a certain hypothesis with reference to the law of variation of the elastic force of the generated gas when occupying different spaces, and then by means of a formula obtained from known mechanical principles, he found what must have been the first or initial force of the fired gunpowder in order to have caused the determined effect, which effect was the initial velocity of a projectile fired from a piece of ordnance of a given length. Finding the forces as determined by these different processes to be nearly identical, he considered his first assumption must be correct.

Professor Euler followed this philosopher and pointed out various mechanical errors which Mr Robins made in his investigations, and if taken into account, would make the initial force equal to 2000 atmospheres.

I also stated that in 1792 and 1793, Count Rumford took up the subject, and endeavoured to determine the force by a direct experiment; the method, however, was totally erroneous in principle, as he assumed "work" to be equal to pressure, and we may observe that it would be no less absurd to say that a mathematical line is equal to an area.

I mentioned, also, that of late years another plan has been adopted

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to discover this force, namely, by assuming:—1stly, A certain re-arrangement to take place in the elementary particles of the ingredients. 2ndly, A certain heat to be evolved by the chemical action. 3rdly, Boyle's and Mariotte's law to exist with regard to the effect of the density upon the elastic force. 4thly, Gay Lussac's law with reference to the effect of the temperature upon the force.

This method however fails, from the great uncertainty which exists with regard to the latter hypothesis.

I lastly pointed out a method in which this interesting and important problem might be solved, namely, by extensive experiments with the Gun and Ballistic Pendulums, the Gun being varied in length.

We now proceed to the second division of our subject, namely,—*The Motion of Military Projectiles.*

In order to solve the most simple problem in Gunnery, namely,—The motion of a projectile in a vacuum, a knowledge of the following mechanical laws is necessary. 1stly, The nature of the motion produced by a propelling agent. 2ndly, The law of falling bodies. 3rdly, The effect of a force acting upon a body in motion.

We find from the History of the Science of Mechanics, the most erroneous notions entertained with regard to the whole of these mechanical principles, until the middle of the 17th Century. In fact, until the year 1638, when Galileo published his celebrated "Dialogues on Motion," the "Aristotelian Physical Philosophy" was generally received and taught in the schools, and we may gather from Aristotle's explanation why a stone thrown from the hand continues to move for some time and then stops? what opinion was entertained with regard to the first principle. He reasons thus:—"If the hand was the cause of motion, how could the stone move when left to itself? if not, why does it ever stop?" And he answers this difficulty by saying, "that there is a motion communicated to the air, the successive parts of which urge the stone onwards; and that each part of this medium continues to act for somewhile after it has been acted upon, and the motion ceases when it comes to a particle which cannot act after it has ceased to be acted upon."

So that from this reasoning it would appear, that as it is the medium that continued the motion, the body would cease to move, when it left the hand, in a vacuum.

In fact, the great mistake made by philosophers up to the time of Galileo was that of supposing, that as a force is requisite to move a body, so a perpetual supply of force is requisite to keep it in motion: even Kepler's reasoning upon the motion of the heavenly bodies depended upon this assumption.

With reference to the second point, viz.:—The motion of falling bodies. The opinion maintained by the Aristotelians at the time of Galileo was,

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that bodies fall quicker exactly in proportions to their weight. The master himself asserts this in express terms, and reasons upon it, so that according to this doctrine, a body weighing 10 lbs., would in falling acquire ten times the velocity of one weighing one pound.

And lastly, upon the third principle, viz. :—The effect of a force acting upon a body in motion, or the law observed by nature in the composition of motion, most curious notions were entertained, as may be judged from the speculations of writers on projectiles in the 16th Century. For instance, Santback, in 1561, imagined that a body thrown with great velocity went in a straight line until all its velocity was exhausted, and then fell directly downwards. He has, in fact, written a treatise on Gunnery, founded upon this absurd hypothesis. Santback, however, represents the path of a projectile as partially descending before its final fall, and then its descending by *steps*, and not in a curve.

Another doctrine which agrees better with the phenomena, although not much more philosophical, was that propounded by Tartalea in 1537, and by Revius in 1582, by which the path of a cannon ball was represented as consisting first of a straight line in the direction of the original projection, then of an arc of a circle, in which it went on till its motion became vertical downwards, and lastly of a vertical line in which it continued to fall. The latter writer, however, was aware that the path must, from the first be a curve, and treated it as a straight line only because the curvature was very slight. Galileo, in his celebrated "Dialogues on Motion," published in 1638, in treating of projectiles, asserts the true law, which is now termed the 1st law of motion, or the law of inertia. He says, "Conceive a moveable body upon a horizontal plane, and suppose all obstacles to motion be removed; it is then manifest that the body's motion will be uniform and perpetual upon the plane, if the plane be indefinitely extended." And his pupil Borelli, 1667, states the proposition generally, that "velocity is, by its nature uniform and perpetual." And the second part of this law was afterwards given by Galileo, viz.: that the motion of the body when left to itself, will not only be uniform, but also rectilinear.

This great philosopher was also the first to solve the problem with regard to the motion of falling bodies. "Bodies," he says, "will fall in the most simple way, because natural motions are always the most simple." When a stone falls, if we consider the matter attentively, we shall find that there is no addition, no increase of the velocity more simple than that which is always added in the same manner, that is, when equal additions take place in equal times, which we shall easily understand if we attend to the close connexion of motion and time.

From this law, he deduced, that the distances descended from the beginning of motion must be as the squares of the times, and Galileo boldly asserted, that if there were no resistance to the bodies (that is in a

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vacuum), a lock of wool, or a piece of lead, would acquire the same velocity in the same time.

The discovery of the third principle, which we have stated as necessary to the solution of our problem, namely, the effect of a force acting upon a body in motion, is also due to Galileo; for in his "Dialogues" he asserts, that a body projected horizontally will retain a uniform motion in the horizontal direction, and will have compounded with this a uniformly accelerated motion downwards, that is, the motion of a body falling vertically from rest; and he states generally, that in all cases, the motion which a force would produce is compounded with the motion which the body previously has.

These laws being once established, the path which a projectile would describe in a vacuum was easily determined, and we find that Galileo states it to be in the curve of a parabola; and, moreover, that this would be the path described by a Military projectile, unless so far as it would be diverted from that track by the resistance of the air.

We should have imagined, after this hint of Galileo with reference to the resistance of the air, that when the parabolic hypothesis was not found in practice to give true results, the right cause would have been assigned: but it was not so. For instance, Robert Anderson, who made a great number of experiments on Gunnery, and published two works in 1674, and 1690, when he found that the results could not be accounted for by the parabolic hypothesis, framed a new hypothesis, which was, that a projectile at its first discharge proceeded to a certain distance in a straight line, from the end of which only it began to describe a parabola. This line he calls the line of the impulse of the powder, and supposes it the same for all elevations.

The celebrated Dr Hally, also, in the "Philosophical Transactions" of 1685, when solving a problem in Gunnery, says: "The opposition of the air it is true, is considerable against all light bodies moving through it, as also against small ones; but in large and ponderous shot, this impediment is found by experience, but very small, and may be safely neglected." Newton, in his "Principia," which was presented in manuscript to the Royal Society in 1686, related the results of experiments upon the resistance of the air to bodies moving with small velocities, from which, it appeared, that the resistances increased as the squares of the velocities, and he hints a suspicion that they will increase more rapidly in swifter motions.

Huygens seems, also, to have alluded to this principle in a Treatise on Gravity, which he published in 1690, in which he gives an account of some experiments tending to prove that the track of all projectiles, moving with very swift motions, was widely different from that of a parabola.

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Newton, in his "Principia," has given an indirect view of the nature of the curve described by a projectile in the air. John Bernouilli pointed out some error in this solution, which was afterwards corrected by Newton, in the second edition of the "Principia" in 1712. In 1718, when the quarrel between the admirers of Newton and Leibnitz waxed hot. Dr Keill, who had come forward as a champion on the English side, proposed this problem as a challenge, imagining, that what Newton had not discovered, no one of his time would be able to discover. Bernouilli speedily solved the problem; and reasonably enough, according to the law of honor of such challenges, called upon Keill to produce his solution, but Dr Keill was unable to do this, Bernouilli then published his solution, with very just expressions of scorn towards his antagonist. Now, although at this time, it was admitted that the resistance of the air would have some effect upon the motion of Military Projectiles, the Parabolic Hypothesis was generally entertained, and it was not until 1742, when Robins published his "New Principles of Gunnery," that the true cause of the great deflection in Military Projectiles from the curve was established.

Mr Robins, in a paper submitted to the Royal Society in 1746, makes the following remarks:—

"That all bodies moving through the air have their motions in some degree impeded by the resistance of that medium, is what, I presume no person, however slightly acquainted with philosophical enquiries, will deny: but that the quantity of this retardation is so great, as to render it necessary to be considered in the determination of the ranges of all kinds of Military Projectiles, has been often and vehemently denied, and this not so much as by practitioners (whose opinions, though extremely inaccurate, have perhaps on this occasion been to much slighted) as by persons well skilled in mathematical learning, who have written of the motions of projectiles, and whose treatises on this subject are generally esteemed and assented to; for if it were necessary a large quantity of geometers of note might be here produced, who have asserted in their works, that in the operations of Gunnery it was too minute to merit attention: and I do not remember that any other has formally or expressly contradicted this position, whatever in general may be concluded what some of them have at times advanced as to the laws observed by resisted bodies. Indeed, I may venture to affirm, that it is now the almost universal opinion of those who have studied the doctrine of projectiles, from the treatises which have been published thereon, that all shells and bullets in their flight do nearly describe the curve of a parabola, and, consequently, that the resistance of the air to the motion of these bodies is altogether inconsiderable.

"The prejudices, then, of many persons, whose reputations for knowledge weigh much with mankind, being contradictory to what I know to be fact, both from reiterated experiments of my own, and from geometrical deductions founded on the unquestioned experiments of others: it is highly necessary to remove, in the most unexceptionable manner, these

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false positions, authorized by great names, and confirmed by the prescription of near an age, for, till this is done, all attempts to complete the theory and practice of Gunnery must be necessarily ineffectual. Since, I am fully satisfied, *that the resistance of the air is almost the only source of the numerous difficulties which have hitherto embarrassed the science;* it is evident, that till the reality and efficacy of this resistance is once established, it will be impossible to produce a candid hearing to any discoveries that may depend thereon, but on the contrary, every speculation of this kind will be treated as ridiculous and chimerical."

Mr Robins then goes on to state, that an iron bullet weighing 12 lbs., moving with a velocity of 25 feet per second in the atmosphere, will meet with a resistance of not less than ½ an ounce, and that the resistance will increase up to a certain point in the duplicate proportion to the velocity, as determined by his experiments.

In another paper, which was read before the Royal Society a few days later, he states:—

Firstly. That till the velocity of the projectile surpasses that of 1100 feet per second, the resistances may be esteemed to be in the duplicate proportion of the velocity.

Secondly. That if the velocity be greater than that of 1100 or 1200 feet per second, then the absolute quantity of that resistance in these greater velocities will be near three times as great as it should be by a comparison with the smaller velocities.

For instance, the resistance of a 12 lbs. shot, moving with 1700 feet velocity, instead of being 144½ lbs., will now be three times that quantity, or 439½ lbs.

The method by which Mr Robins determined the resistance of the air to Military Projectiles is exceedingly ingenious, it is, in fact, the same plan which has been since his time, almost universally adopted for the same purpose, and is as follows:—

Balls were discharged from a musket under precisely similar conditions, and made to impinge upon the block of the Ballistic Pendulum, placed at various distances from the piece.

The several velocities with which the shot were moving when they struck the Pendulum being thus determined, it was easy by the third law of motion, discovered by Galileo, to find the resistance or pressure which must have acted upon the projectiles. For instance, Mr Robins fired two balls ¾ of an inch in diameter, with the same charge of powder at the Ballistic Pendulum, placed in the first instance at 25 feet from the piece,

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and in the second case at 75 feet, and it was found that the first shot struck the pendulum with a velocity of 1670 feet, and the second with a velocity of 1550 feet.

Taking then the motion as uniform, and as the mean of 1670 feet, and 1550 feet, whilst passing over the 50 feet; the time in traversing this distance would be $\frac{1''}{32}$ nearly.

Now, it is known from experiment, that $\frac{3}{4}$ of an ounce pressure acting upon $\frac{3}{4}$ of an ounce mass for *one second*, will produce a momentum of $32 \times \frac{3}{4}$, and when the same pressure acts upon the same mass for $\frac{1}{32}$nd part of a second, it will produce a momentum of $\frac{3}{4}$; and, therefore, by the 3rd law of motion, which states, that the momentum lost or gained by a body in a certain time will be proportional to the pressure, it appears, that in order for the ball to lose $120 \times \frac{3}{4}$ momentum in $\frac{1''}{32}$ the pressure must have been $120 \times \frac{3}{4}$, or 120 times its weight, or 10 lbs. We may remark, that this pressure can be found by a more simple process, viz.: by subtracting $\frac{1}{2}$ of the *vis viva*, or the "work" represented by $\frac{V^2}{2g}$ and $\frac{V_1^2}{2g}$, which the balls possessed when striking the block, from each other, and then knowing the distance in which the work was lost, the pressure is immediately determined, and as the difference in the velocities is very small, this pressure will give a very near approximation to the resistance of the air to the ball moving with the mean velocity.

As it was impossible by the above means to find the resistances to comparatively slow motions, on account of the balls not penetrating the block sufficiently to be retained there, Mr Robins designed a machine whereby the resistance might be determined to velocities, however small. This machine consisted of a brass barrel moveable on its axis, and so adjusted by means of friction rollers, as to be retarded, but very slightly, in its rotatory motion; the barrel was fixed to a frame, which might be adjusted by screws, in order to place the axis vertical. The axis itself is continued above the upper plate of the frame, and has a light brass cone attached to it. From the lower part of the cone is extended a long arm of wood very thin, and cut feather edged, and at its extremity is a contrivance for fixing on bodies whose resistances have to be determined, and to prevent the arm from swaying out of its horizontal position by the weight of the body, a brace of fine wire is fastened to the top of the cone, and supports the end of the arm.

Round the barrel is wound a fine silk line, after this line has taken a sufficient number of turns, it is conducted horizontally to a pully over which it passes, and a proper weight is hung at its extremity. This weight, when left at liberty, will descend and turn the barrel, together with the arm and the body fixed to it: and while the resistance of the body and

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the arm, and the friction of the axis is less than the weight, the motion will be accelerating, but when the weight becomes equal to the retarding forces mentioned above, the motion will become uniform, and when this takes place, will be indicated by counting the turns for a certain short time. The plan adopted by Mr Robins in using this machine was first to find the weight that was equal to the pressure upon the arm caused by the resistance of the air, and that due to friction, and then to find the weight which cause a uniform motion when the body was attached, and after subtracting the one from the other, and allowing for the leverage of the arm, the resistance to the body alone, became known.

It was by these two methods that Mr Robins reduced his laws of resistance to bodies moving with small and great velocities.

Dr Hutton succeeded Mr Robins in the investigation of this important problem, and to this eminent mathmematician we are indebted, not only for throwing much light upon this subject, but also for *establishing* other laws of great use, both in the Art, and Science of Artillery.

The whole of Mr Robins' experiments were made with ordinary musket balls, and from the material of which they were composed, namely, lead, being of so soft a nature, the form of the projected body was liable to much alteration. Dr Hutton's experiments were carried on with iron balls, and of a much larger diameter than those used by Mr Robins, and consequently more dependance can be placed upon the law of resistance, as determined from the data afforded.

The methods adoped in these experiments for determining the resistances to the balls when moving with different velocities were precisely similar to the ones described, but the apparatus was of much superior description.

Dr Hutton having found the resistances to a certain sized ball, moving with a variety of velocities by direct experiment, in order to determine the resistances corresponding to any velocities, such, for instance, as 10 feet, 20 feet, 30 feet, &c., he had recourse to the following method:—

Draw two lines (fig. 4) *XY* and *XZ* at right angles to each other, of an indefinite length. Then from a scale set off upon the line *XY*, the series of velocities from the point *X*, and also upon the line *XZ*, the corresponding resistances. From every pair of these points draw lines parallel to *XZ* and *XY*, and where the pairs intersect each other draw the curve *AX*. The lines *XY* and *XZ* are then graduated at any convenient equal intervals, and the resistance to any given velocity may then be determined by drawing through the point on *XY*, indicating this velocity a line parallel to *XZ* to meet the curve, and a second line drawn through

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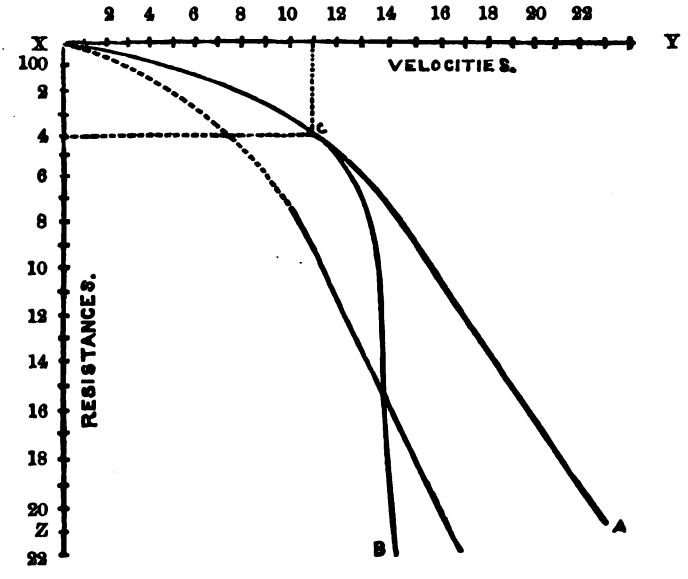
this point of intersection parallel to *XY* will meet *XZ* in a point, the graduation of which will indicate the required resistance.

Fig. 4.



It was by this simple plan that Dr Hutton constructed his tables of resistances. This geometrical method is not only useful as affording a ready means of determining such points, but it also shows at a glance the nature of the laws by which the effects are governed. For instance, it will be seen at once by a bare inspection of this figure, that the law of resistance as propounded by Robins is altogether erroneous, for this philosopher stated, that when the velocity of the body became greater than about 1100 feet per second, the resistance suddenly increased to three times the amount which would result from the law observed when the body was moving with a slightly smaller velocity.

The correction of this error was of very great importance, as it involves a principle affecting to a very considerable extent the progress of the Art of Artillery, for if this sudden increase were according to the true law, or *theory*, there would manifestly be little or no advantage in giving to a projectile a greater initial velocity than about 1100 feet: this erroneous opinion is even to the present day entertained by many.

Now so far from Robins' law being correct. Dr Hutton has shown that there exists, in fact, an opposite tendency, for the ratio between the velocities

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and resistances, gradually increases above that of the squares up to a velocity of 1600 feet, and then gradually decreases from the maximum variation, and this is no other than what we should have expected, for the *principal cause of the deviation* from the simple law of the squares, is due to the rarefaction of the air behind the projectile, and the effect of this will evidently cease to increase the ratio after a vacuum is formed.

Dr Hutton, from the data afforded by his numerous experiments, endeavoured to obtain a general expression which would represent the resistance to any velocity, and upon this point he makes the following remarks:—"This problem is very difficult to be performed near the truth, on account of the variable ratio which the resistance bears to the velocity, increasing always more and more above that of the square of the velocity, at least to a certain extent, and it appears that there is no single integral power whatever of the velocity, or no expression of the velocity in one term only, that can be proportional to the resistances throughout. It is, indeed, true, than such an expression can be assigned by means of a fractional power of the velocity, or rather one whose index is a mixed number. But this formula, though serving very well for some particular resistances, or even for constructing a complete series of tables, is not proper for the use of problems in which fluxions or fluents are concerned. We must, therefore, have recourse to an expression in two terms, or a formula containing two integral powers of the velocity, as v^2 and v, the first and the second powers affected with general coefficients m and n, so that the formula will be $mv^2+nv=r$." And by this method Dr Hutton, by a series of guesses, found a formula, which would represent approximatively the resistances to any velocities.

Dr Hutton also made a great number of experiments with Robins' whirling machine, for the purpose of determining the laws of resistance to bodies of different forms, and from these experiments the following general principles amongst others were deduced:—

1stly. That with the bodies of different sizes, but of the same form, the resistances with similar velocities are nearly as the surfaces, increasing a very little above that proportion in the greater surfaces.

2ndly. That the round ends and sharp ends of solids suffer less resistance than the flat or plane ends of the same diameter. The cylinder and flat ends of the hemisphere, and the cone, suffer more than the round or sharp ends of the same. But the sharper ends have not always the smaller resistance.

3rdly. When the hinder parts of bodies are of different forms, the resistances are different, though the fore parts are the same.

4thly. That the resistance on the base of the hemisphere, is to that on the rounded side, or on the whole sphere nearly as 2½ to 1.

In 1837, M. M. Piobert, Morin, and Didion, presented a memoir to the Institute of France, in which was contained some remarks upon Hutton's

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law. M. Piobert objected to the method by which Hutton obtained his formula, and after carefully considering the question, he found that an expression containing the second and third power of the velocity, and affected by certain coefficients, would satisfy the general conditions far better than Dr Hutton's equation. A very extensive course of experiments were carried on at Metz, 1839, and 1840, under the superintendence of officers of great talent and experience. One object of these experiments was to determine the law of resistance of the air. M. Piobert, after carefully analyzing the whole of the results, deduced a formula, which expressed with great accuracy the amount of resistance, under almost every variety of circumstances.

This formula is similar, in its general character, to the one already mentioned, that is to say, it contained two terms, the one being the square of the velocity, and the other the cube, but the coefficients by which these terms were affected, differed from those in the expression which he obtained from Dr Hutton's experiments.

Now, although the law of resistance of the atmosphere to round projectiles is not absolutely expressed by Piobert's formula, yet taking into account the nature of the experiments from which it was obtained, together with the ability of those who conducted them, we may with confidence assert, that it is the nearest approximation to the theory which has been hitherto given.

Having thus traced the progress which has been made toward obtaining a knowledge of the theory of resistance of the atmosphere, we must now turn to the problem in which this law enters as a necessary and important element, viz :—

The Motion of Military Projectiles.

Newton was the first that attempted a solution of this problem, but although he succeeded very well upon the hypothesis that the resistance was proportional to the velocity, he was unsuccessful in his attempts to determine the trajectory, in the case when the resistance was assumed to be as the squares of the velocities. John Bernouilli gave the first solution to this problem upon the latter hypothesis, at least he obtained a result far more correct than Newton.

Three general methods have since been adopted by mathematicians, for the purpose of determining the trajectory of a projectile in the atmosphere.

The value of certain quantities connected with the trajectory (for instance the co-ordinates, velocity, time, &c.) having been obtained in the form of symbolical integrals, which do not admit of exact computation, different methods have been adopted to obtain approximate results.

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1stly. The limits between which the integrals are to be taken have to be divided into parts, and the approximate value of the integrals are obtained by taking the mean of the values of their corresponding parts. Of this kind is the method of Quadratures and Euler's method. The approximation is the more exact as the number of parts is increased.

In the second method.—The values of the integrals are obtained in a *series* arranged according to the *powers* of the given quantities. The computation is in this case, the more accurate the more convergent the series, and the greater the number of terms that are taken into account. This method has been employed by Lambert, Borda, Tempelhof, Français, and some other mathmaticians.

The third method consists in replacing the expressions which cannot be integrated by others, which are nearly the same, and which can be integrated. The values thus obtained are definite, and the approximation therefore cannot, as in the other two methods, be carried on to any desired degree of accuracy. The excellence of the method depends upon the more or less happy choice of the expressions selected, which ought to give results sufficiently accurate for the proposed object, and render the numerical computation as easy as possible. Such is the ingenious method of Borda, in which he is followed by Besont, and which has been since perfected by Legendre and Français.

Euler having found approximate values for the various quantities determining the trajectory for a series of points in it, found the trajectory itself from these values by a corresponding series of straight lines, each having the mean of the inclinations determined for its two extremities. Legendre improved upon this by substituting circular arcs for these straight lines, and Didion obtained still greater accuracy by the introduction of parabolic, in the room of Legendre's circular arcs.

Français has treated the subject very elaborately under the second method, and obtained some very remarkable series; but though he has also supplied tables to assist in their numerical computation, the processes are still very complex and difficult: and when it is considered that the results obtained must be still inaccurate from the error in the assumed law of the resistance of the air, such results can ordinarily be scarcely considered a compensation for the time bestowed in their determination.

Poission has given the equation of the trajectory of a projectile when fired at a small elevation. This equation may be used often with great advantage in determining many points with reference to the principles which govern the motion of military projectiles, and it has been found from experiments to give very accurate results when the elevation is not more than $\frac{1}{2}^{\circ}$, and when the initial velocity is considerable: and at a much higher elevation, when the velocity is that which is ordinarily used in Ricochet fire.

We have endeavoured this evening briefly to point out the gradual progress which has been made, during the last two centuries, in that branch

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of the Science of Gunnery which refers to the opposing force, which continually acts upon a projectile in its flight.

On a former occasion, the propelling agent was the matter of consideration. These are manifestly the two most important subjects relating to the Science. In fact, the laws which govern the effects produced by these two forces constitute the very foundation of the Science of Artillery.

There are other matters, however, connected with the subject, which are no less important in their practical bearing, a comprehensive knowledge of which is absolutely necessary to the efficiency of an Artillery Officer. We propose to enter upon these subjects at some future time.

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Remarks on the Position, Construction, and Armament of Sea Coast Batteries.

By Captain J. B. Parkin, R. A.

At no period can the subject of our Sea Coast Defences be otherwise than of the utmost importance to us, as a pre-eminently commercial, wealthy, and insular people.

With a coastage (including that of Ireland) of about 3500 miles, in many places accessable by the largest ships of war, and surrounded as we are by our Ports and Dockyards, warlike and commercial:—the former, consisting of extensive depôts of ships in a more or less defenceless condition, "in ordinary," as it is called, and of immense and valuable stores of every kind—the latter situated generally at or near the gorge of those streams of national wealth, our rivers, and containing everything, which both in quantity and description, enriches a nation, and therefore supplies to it a main element of *power;* at no time can there be a subject of more serious importance to our security and prosperity, than a complete and efficient system of Coast Defence. Yet these defences are built, armed, and thoroughly equipped, neither in a month, nor hitherto in a year: and who can at *any* time possibly forsee with whom, or under what circumstances, we may be at war? Or who can foretell what, or how rapid may be the change of circumstances which war may bring with it.

It cannot be doubted, that the application of steam power to ships of war, has tended to neutralize that complete naval supremacy which we have hitherto enjoyed: and for this reason, that seamanship (by which, I mean dexterity in going aloft, and in the management of sails) is no longer, as it was formerly, the *most* essential and the first qualification, necessary in those who man, or rather in those who garrison our ships.

Two new principles, and two corresponding classes of men have been introduced into the Sea Service of the world, viz.:—the Steam Engine, and a very different and much more formidable Armament, requiring the former, a useful body of Naval Engineers to superintend the efficiency of the machinery: the latter, a much greater application of science in the practice of Gunnery, and as a consequence, a scientific Corps of *Artillery*, to make use of that armament. These, now, are matters of so much im-

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portance, that their advantages in the possession of, numerically, a very inferior fleet, would render it not only perfectly unassailable by any other not possessing them, but would render also the destruction or capture of the latter by the former, under ordinary circumstances, that is, without the extraneous aid of Coast Batteries, an easy process. Hence the necessity for the universal adoption of heavy armaments, and of steam as the propelling agent, instead of the comparatively light armaments, large spars and sails, and consequent heavy *superincumbent* weight, of former days: and hence the substitution to a very great extent, of the certainty and economy of science for former uncertainty, and for the necessarily extravagant expenditure of time, and of human labor. Hence, also, the necessity of increasing the number, and of augmenting the power of our Coast Batteries.

Amongst the principal advantages of the strictly defensive system to which I particularly allude, are, that whilst an Army in the Field is utterly unable to prevent either the attacks of a hostile Fleet, or the landing of a hostile Army, under cover of the guns of its ships; and whilst a Fleet, when acting in defence of an extended coast, must be continually on the move, never stationary, and often scattered; a well-planned and efficient system of Land Batteries, garrisoned by an Artillery force equally efficient, renders us when necessary, independent comparatively of the assistance of a large Army, or of a Fleet. It is, in itself, far more durable, and in every respect less *costly*, than are fleets, and renders some reduction in the numbers of both men and ships, a safer operation than can possibly be the case under other circumstances.

Supposing then, the peculiar advantages of this *Defensive* system to be acknowledged, the question afterwards becomes one embracing very important details, viz.:—What are the circumstances which should determine the best Armament, command, system of arrangement, and the material of construction of Coast Defences? And *vice versa*,—What is the best Position, &c., for Coast Batteries, under given circumstances? These details are each and all so entirely dependent on each other, and on the power of *Modern Artillery*, as in effect to be inseparable, and the accompanying remarks on a subject involving so much of study and experience, are written with much diffidence, not however without some hope, that they may possess utility.

On almost all occasions in war, the range, weight, and nature of the projectile, which, together constitute the *power* of Artillery, render it necessarily the chief arm, both in the attack, and in the defence: and as either of the latter can be considered only with reference to the other, it follows, that an Artillery Officer should be as good a judge, as to the disposition made, or which could be made, by the enemy of his guns, and of the effect therefore to be calculated on, and provided for; as he should be likewise of the best disposition for his own guns; and equally

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so, whether with a view to offensive or defensive operations on his own part.

And here I may observe, that the *principles* involved in the determination of the best position for Artillery, are precisely the same, whether that position is destined to be permanent or temporary; the intervention of a *parapet*, or *wall*, is a secondary question, and is quite subservient to the considerations affecting the position for the *guns*, which latter, on the contrary, must necessarily decide the position, &c., of the parapet. In the field, where circumstances are momentarily changing, the judgment (of the Commanding Officer of Artillery,) should be as sound, as his decision should be quickly executed. But where time is not of the same immediate and momentous importance, as in the preparation of defensive, and generally, of more permanent measures, the quick eye and judgment, so absolutely necessary in the former case, is in the latter less essential, though his judgment should, perhaps, be scarcely less correct. In short, it is the best and proper position for the weapon itself, that is, for the *guns*, which should determine where the parapet (which is *not* an essential, but an *accessory*) should be, and *not*, as I regret to say, appears to be too often conceived and acted upon—the situation of the parapet, which should determine what may, or may *not*, be the best position for the guns. Clearly, therefore, the question of site, or in other words, the best situation for the *guns*, is an *Artillery* question, and should in justice be, not only in the *field*, but *invariably* subjected to the choice and decision of *Artillery* Officers. To make it otherwise, is to sacrifice the Science of Gunnery to that of the Engineer, in themselves perfectly distinct, and is at once unfair, as well as impolite in practice. In fact, it would be as unfair and incongruous, as a rule,—to the Engineer, were Artillery Officers usually employed in Mining Operations, the Construction of Roads, &c., as it is at present to the Artillery Service, in employing Engineers to select the site of their Batteries. It is an unwise and unnatural separation of the science and theory, from the practice of Artillery, and is always *impolitic* and *expensive*.

Batteries destined for the defence of a coast, differ from inland defences in these essential points: firstly, in the suddenness and violence with which they may be attacked: and secondly, that a very concentrated and powerful fire may as suddenly *cease*, and every vestige of an enemy disappear, probably as suddenly and as quickly as he appeared. Those *immediate* preparations, which are indispensable in attacking a fortress by land, and which afford warning and time to its defenders, as well as the possibility of assuming the offensive, are in the case of Coast Batteries, wholly wanting and impossible. In time of war, therefore, and, indeed, in time of peace also to a certain extent, it behoves the Officer Commanding the Artillery, (whose *sole* responsibility it should be) to be ever alert and ready for any contingency. In war time, he may feel sure, that a vigi-

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lant and enterprising enemy would scarcely overlook the advantages afforded him by steam-power, and the obscurity of night, or of foggy weather. It may be true, that at the present moment, there is little such danger to anticipate, or rather to apprehend; but circumstances are ever altering, as well as being beyond our control; and no one can tell what, in war, as in the hardly less difficult games of politics, or of love, a day may bring forth.

With regard to the best position for Batteries, and to all the other details connected with the subject of land defences in general, there is, with precisely the same data, an almost infinite variety of opinion, even among those whose opinions ought undoubtly to carry weight. One will think so many feet the best height for a Coast Battery, another inclines to having it *a fleur d'eau*; one objects under any and *all* circumstances to stone and casemates, another to earth, and to the terrace arrangement, as proposed by Mr. Ferguson.

It seems to me, that *circumstances* have a great deal more to do with the selection of *either* of the above opinions, as the best under existing circumstances, (and, consequently, with the *rejection* of some or most of the others,) than any *rule* or *system*, minutely conceived, and admitting of little or no *adaptibility* to many circumstances which will present themselves; and which system, may in some, perhaps in many cases, prove *wholly* ineffectual. In fact, as is well known, the very cause of the almost universal failure of the defence has been the adhering too blindly to system and to Vauban, and particularly to brick or stone, and to straight lines. Not but as I have already hinted, there are cases, as it appears to me, when *stone* must and should be resorted to, though from being generally dangerous to its defenders, very expensive, and difficult to repair, if admitting of repair at all—it should never be resorted to where it can be advantageously dispensed with; in short, there is but *one* case, as I shall presently explain, where stone should be employed.

The system of straight lines is defective, as being liable to be enfiladed, as introducing angles, (generally very difficult to defend, and consequently very weak,) and as admitting of nothing like the same comprehensiveness of fire, convergent or divergent, which pertains to a curvilinear arrangement, and to that only: and which arrangement may consist, or be made to consist of a series of *convex* Batteries, arranged in a *concave* form; a *front* constructed on which plan might be continued, or rather repeated, as far as, or wherever necessary. The curve given to each Battery respectively, should be such, as whilst diminishing, as far as possible, the danger of being enfiladed, will yet admit of the flank guns, or those at each extremity of the curve, being traversed over the greatest possible arc. In such a system, nearly every gun might be brought to bear upon any point, wherever situated, thus obtaining a very converging fire; or it may be made as divergent as circumstances may require. In the bas-

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tioned, or rather the straight-lined system, on the contrary; every angle, but more especially the salient angles, tends to weaken the fire; and when the number of angles in such a front (namely, six) is considered, it is scarcely too much to say, that the fire lost, is as much as that which is effective, or in other words, that in the circular system, the fire might be doubled at least.

The further development, however, of this important subject, must be delayed for a future occasion, or undertaken by abler hands; it would certainly occupy too much time and space at the present moment. With regard to the employment of stone, and to the straight-line system, exceptional cases may occur more frequently in the defence of Coasts; *i. e.*, in so far as the Batteries are intended to act against *shipping* only; because, with regard to stone, the fire of the Batteries *must*, often, to prove effectual, be heavier, and more concentrated than will, in all probability, be obtainable from any but Casemated Batteries, that is from two or three tiers of guns; and with regard to the straight-line arrangement of the guns, it is often easier to prevent the possibility of their being enfiladed (supposing them not to be casemated) by the enemy's ships, than it would be by his Land Batteries, were the place invested.

Whatever may be doubtful, one thing at least is certain, viz.:—that no system can be a good one, which does not admit of being *rapidly* and advantageously strengthened; and that the means of quickly adding to, and strengthening the defences, as also the numbers composing the garrison, should bear a safe and full proportion to the importance of the position to be defended, and to the probable force, consequently, by which it might be attacked: and that in the case of any position maritime or inland, of the utmost importance to a country, such as Portsmouth, Plymouth, Sheerness, and the Mediterranean Fortresses, to England; Brest and Cherbourg, to France; Sebastopol and Cronstadt, to Russia, &c., the means of instantly and constantly increasing the defences, (such as men, guns, ammunition, earth, and sand bags, intrenching tools, &c., &c.,) should be unlimited: and with respect to the *range* and *calibre* of the guns, the *greatest* and most powerful that exists; for it must always be borne in mind, that the attack, either by land or by sea, is made at discretion, and that if twenty line of battle ships is considered an insufficient force, thirty *might* be more successful; and, also, if the enemy can command a greater *range* than can the Artillery of the Garrison or Fortress, the fate of the latter is already decided. The facilities, therefore, of increasing the power of resistance *should* always be, and might almost always be, equal or greater, than those possessed by the attacking force. The range and calibre of the guns most generally used in our Sea Coast Defences, are, in my humble opinion, not nearly sufficient; and the same applies to mortars, with this aggravation, that they are not nearly used in sufficient numbers. Mortars should be placed principally on each flank,

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so as to include between them the whole position of defence; and should the latter be extensive, Mortar Batteries may be placed at intervals between those extreme points. We thus obtain, as it were, a cross-fire of shells, and thus increase the chance (sometimes rather difficult) of obtaining a successful vertical fire. It will generally be practicable, and always advantageous, to know the exact distance (in a straight line) between these flanking points, which straight line might serve as a base, on which to get the *bearings* of each flank respectively, with reference to fixed and known points, or even to moveable objects.

It seems probable, that one out of the many important results of the present war, will be the novelty of the superiority (at least comparatively) of the Defence over the Attack, and *that* in the cases of attacks both by land and by sea; owing, with respect to the former, to this, that the besieged have looked upon the Defence as commencing chiefly with the Attack; and instead of ridiculously squeezing themselves and their resources into the narrowest possible compass, their ingenuity has been directed, rather to the detecting and availing themselves of the opportunity, to attack and harass the besiegers. The defence has been active, not passive; has consisted chiefly in assailing, not in being assailed: the success of which has undoubtedly been very much due to the immensity of their resources, both in men and guns, but scarcely less to the ingenuity they have displayed in the development of those resources; and with respect to the attack by sea, they have been enabled to return broadside for broadside, with the advantage of granite walls against wooden walls. Where there is a fair proportion of guns, mutually; where the calibre and range are at all equal; and where on both sides the gunners do their duty, all of which may fairly be expected; there *never* can be a doubt as to the result, in the case of the attack on granite Casemate Batteries by ships.

In general, Coast Batteries are intended for the defence of Harbours, Arsenals, and Dockyards, sometimes of landing places only, when, however, they will rarely be very formidable. In either case, much must depend in arranging, constructing, and arming them, upon the following circumstances:—

1stly. As has been said—Upon the value and importance of the position Geographically—as an extensive and valuable depôt (of war or of commerce)—as a good and capacious harbour, or by a combination of some or all of these.

2ndly. Upon local peculiarities of situation,—Whether at the mouth of a river, in a bay or other inlet of the sea, &c., more or less sheltered by land or rocks from the wind.

3rdly. Upon the number and nature of the approaches to that position, and the fewer (by water) the better. Whether the latter are open

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or confined, direct or tortuous, free from obstruction, or difficult of navigation. How effectually commanded by land. The nearer to the main object of defence, *i. e.* to the main defences themselves, the more important do these considerations become.

4thly. Whether vessels can run near and past the Batteries, without being obliged to repass them (within range) to escape.

5thly. And most importantly—Upon the depth and description of the soundings, with reference to the nearest distance, at which, at *high* tide, ships could either pass them, (when the *time* they will be under fire must be considered,) or, at which they could take up positions for a regular battle. Whether, in fact, the object of the enemy is to *pass* the Batteries only, or is to *destroy* them. To ships propelled with steam, winds, and currents, are comparatively of little consequence, as they can always choose their own opportunity, and are to a great extent independent of both.

With regard to the first point:—All very important positions should, as nearly as possible, be fortified, so as to prevent any apparent possibility of their being assailed successfully; since, if there is *good* reason to doubt this, (as is too often the case,) their capture or destruction may be worth a considerable risk and sacrifice on the part of the enemy. No expence, therefore, should be spared, to render a Maratime, or other Fortress which is exposed, or likely to be so, as nearly impregnable as it can be made. The means of conveying all reinforcements by a railway from an inland or secure depôt, will materially contribute to its strength, if the attack is to be a prolonged one.

The second and third points may be considered together. Bays, or other inlets of the sea, especially when the entrance is narrow, and the estuaries and mouths of rivers, provided the water is sufficiently deep, form frequently convenient harbours, and eligible situations for Dockyards, Arsenals, and other warlike Depôts. They offer generally many facilities in fortifying. The approaches are often narrow channels, converging as they get nearer to the harbour. Mud or sand banks make them frequently tortuous and difficult of navigation, to an enemy, and may often subject him to the effects of a fire, which he cannot conveniently or effectually return.

Such situations generally admit, also, of a more or less effective cross or flanking fire, which should invariably be taken full advantage of, and so as, if possible, to *cross* at the *narrowest* part of the channel, or approach to the harbour; or otherwise, at any other, the most desirable point, over which the enemies' ships must *necessarily* pass, in order to make an attack.

Should there be any banks or islands above the level of high water,

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and which are within the distance of an extreme range from the main works, they should always be armed with powerful guns, the Batteries built no higher than is absolutely necessary, and retired as far as would be practicable from the front. If likely to fall into the hands of the enemy, the guns should be rendered unserviceable.

These Batteries should, also, if possible, be assisted by a flanking fire from the works in the rear.

A most important consideration relative to the natural strength of a harbour, consists in the nature and number of the approaches or channels conducting to it, *i. e.*, at how many *distinct* or *independent* points; by which, I mean those points which are beyond the range of *mutual defence*, the enemy might possibly attack; and also upon the *front*, with which he may be able to advance to attack the Batteries.

It is evident, that the more numerous these independent points of attack are, and the more extended the front with which the enemy may be able to approach, the weaker will the position be, and *vice versa*. As a general rule, it would seem as if a position would be stronger when concave, that is to say, a concave series of convex Batteries, as before explained, and weaker when convex.

Now, the more concentrated a fire is, the more destructive it may be expected to prove. Circumstances sometimes render this concentration of fire easy to effect on the part of the land defences, and, on the contrary, difficult on the part of attacking ships; and sometimes the reverse, when, however, the position is a bad one, or badly defended; as would be the case generally if the position were of a *convex* form, which latter would cause rather a divergent than a convergent fire. When, therefore, the facilities for obtaining this concentration of fire are in favor of the land defences, the position is so far naturally strong; but when in favor of the enemy's fleet, as when very exposed to an open sea, the position is, in this respect, not so naturally strong, and its capabilities of defence, must depend more upon the command and nature of the ground. With regard to the fourth particular.—Whenever it is the enemies' object to run past the Batteries *only*, his ships will generally do so as quickly as possible, and a few steady shots will do better than a hurried or unsteady fire.

As to the fifth particular.—A first-class harbour, and the way or channels leading to and from it, must be capable of floating and containing vessels of the greatest draught and dimensions, at least during high tides, if not at all times. It must also be more or less *surrounded* by land, so as to be sheltered from the wind and weather, and, in short, so as to render it tolerably secure; and it is on the relative depth of water in various localities, and on the configuration and character of the ground, that its strength, in a military point of view, depends. Of course, the

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less water their is, the less near will the enemy's vessels be able to approach, or at any rate, the smaller will they be, and the less formidable therefore will be his fire: consequently, the less powerful need be the land defences; but when the depth of water permits of the enemy's ships of the line approaching within range, the question becomes a different one, and its solution must again depend very much upon the command and character of the ground.

In the fortification of a harbour or coast, then, the first thing to be considered, after a complete examination of the ground, (taking all levels above *high* water mark) is, at what distance from the Batteries will the enemies' vessels of each class respectively, be able to approach, *i. e.* the *nearest* distance. Having decided this question, by reference to a table of the different draughts, &c., of vessels of different classes, the next thing to be decided will be the best positions for the Batteries, with reference to the character of the ground. If the water is deep, and the ground low, it may be necessary or desirable to retire the Batteries a few hundred yards from the water's edge, the effect of which may, perhaps, be to render useless a proportion of the enemies' guns, those on the lower deck for instance, which are also the heaviest; then, by having heavy guns mounted on dwarf traversing platforms, (or otherwise as may be best under the circumstances,) a great advantage will be gained over him.

But, it may be necessary or desirable that the Batteries should *not* be so retired even though the water is deep and the ground low and flat; as, for instance, in the case of a harbour where cover is required both to intercept the enemy's view of the interior, and for protection to the establishments, stores, ships, &c., there, from the effects of his fire. It is in this case that it appears to me, casemates *must* be resorted to, more especially for the more advanced works which defend the entrance to the harbour. *Here* we should have three tiers of guns; the stone used should be the hardest granite, such as the blue or Aberdeen, and the works themselves should be rendered as fully capable as possible of their own defence, by being protected in flanks and rear, and surrounded on the land side by a ditch.

All works which are somewhat advanced into the harbour, and which are therefore exposed to the enemy's broadsides at short distances, should be similarly built and protected.

Those which are intended by their fire to *enfilade* the harbour, or to *flank* the former, may be constructed of earth; but the guns mounted in them should be heavy and pointing through embrasures, unless at a considerable elevation above the water.

Where casemates are employed it should be an object to obtain the heaviest possible fire with the least exposure of the interior; the power consequently of the batteries should consist more in the *weight*

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of metal than in the *number* of pieces, so as to necessitate as few embrasures as possible.

Considering also that the muzzle of a gun performs but a very small arc, in order to give a great increase or decrease of range, by elevation or depression, and that on the contrary, a much larger angle is comparatively moved over by the gun (horizontally) to get more *lateral* range, *i. e.*, in traversing; it would seem from this that the form of an embrasure should be that of an ellipse, having the major axis horizontal, and not rectangular nor circular, since in both of the latter there would be an increased and unnecessary exposure.

By way also of decreasing the sectional area of this ellipse, the gun and carriage might be made to work more *within* the embrasure itself, by which the trail might in traversing be made to perform as large an arc as the muzzle, or the whole arc described in traversing would be performed, half by the muzzle, and the other half by the trail; the *neutral axis*, as it were, being situated in the straight line passing horizontally through the *centre* of the thickness of the wall, instead of being in the same plane as the *interior* surface of the wall. This would afford still further protection to the gunners, without weakening the masonry. These (casemate) Batteries should be resorted to only where from their situation they may be exposed to the full effect of the enemy's broadsides, *i. e.*, where they might possibly be engaged by the enemy's ships of the line, at or *within* a distance, (nearly horizontal) of 1500 yards. They should, however, always be flanked or assisted by earthen Batteries, placed wherever a sufficient height above the water would render them useful and safe from the point blank fire of the enemy's guns.

Where, from the sloping nature of the ground one Battery may be made to fire over another, they may be advantageously constructed of earth, and the heavier and more concentrated the fire which can be obtained by this means, the better and more formidable will the position be.

With respect to the best perpendicular height (above the water) for Batteries, this must depend upon the nearest distance at which the enemy's vessels may be able to attack, the greater this distance is, the less necessary will a considerable relief be; but as a rule it may be stated that the land Batteries should always command ships, and *not* ships the land Batteries. It is necessary that the *height* of the Battery above the water should be proportioned in such a manner to the *draught* of water, as to render the terre-plein of the former perfectly secure from the effects of small arms, &c., fired from the "tops" and elevated positions in ships.

As another rule, Batteries should never be *a fleur d'eau*, when the enemy's ships, or at least his two deckers, can approach them at or within a distance of 2000 yards. In estimating the limits within

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which the relief of Batteries (or the height of their crests above the water) should be as much as possible confined; and with due reference to what has been before said, it would appear to me that 12 or 15 feet as the inferior, and from 50 to 60 feet as the superior limit, admits of adaptability to most if not to any circumstances which could occur. With regard to either of the two extremes, I think a greater height than 60 feet would more frequently be found useful (as when the defence of a particular spot is the object, and when the range and *depression* will consequently be well known), than a Battery *a fleur d'eau* will ever or will often be.

With respect to the terrace arrangement as proposed by Mr. Ferguson, I confess I am at a loss to see how it can effectually be *constructed* or employed, unless in the manner just pointed out, viz., where a *natural* slope admits of Batteries being built on it, the one behind and above that in its front; and even in this case the distances horizontal and vertical, by which the Battery in rear would differ in situation from that in its front, must be very considerable to admit of an *effectual* and *simultaneous* fire from all such Batteries.

In Mr. Ferguson's system of *construction* it appears to me that the works in rear can be effectual only, when those in front are taken or destroyed, that is as a *second* line of defence; otherwise none but the front and lowest battery could fire either shell or hot shot, or indeed could fire at all as it seems to me, for not only would the wads projected from the Batteries in rear prove seriously interrupting to the gunners in the front, but the ignited pieces of flannel also, similarly projected into a space, narrow, and where much powder must necessarily be exposed, would prove so dangerous, that I doubt much if any but the front or *one* battery could fire at the same time. Yet to obtain any advantage by a *concentration* of fire at useful distances by this method, the batteries in rear must be too close to those in front to permit of all, (as it appears to me) being worked simultaneously.

As has already been observed, the means, such as men, guns, earth, intrenching tools, &c.,) should *always* be available for instantly and rapidly increasing or repairing the defences of a fortified position whether maritime or inland. Upon the facilities with which they can be employed must ultimately depend the safety of any position. Casemate Batteries are adapted *not* to a systemtic and prolonged attack, but to meet and return the heavy broadsides of ships engaging them at comparatively short distances. They should therefore invariably be covered and protected by earthen works, which latter should be rapidly increased and strengthened, in proportion as the liability to being attacked becomes more imminent. It cannot be borne too clearly in the mind that, after all, the *strength* of a fortified position depends upon the celerity with which *more guns* can

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be put into position and worked. Earthen parapets are most quickly thrown up, as well as being more easily and quickly repaired, therefore, earth will be their best cover. It is, of course, to be first presumed, that the position chosen for the *guns* is the best that can be had; and, moreover, that the nature and calibre of the Artillery employed, and upon which everything depends, are sufficiently powerful.

Before closing and summing up the foregoing remarks, I will venture a few more, as to the way in which the various modes of attack by the enemies' fleet should be met.

If the enemy, trusting to the number of guns in a powerful fleet, and to a sufficient depth of water, should advance boldly to engage the Batteries at the closest distance possible—those Batteries which command the approach or approaches, either by an enfilade fire or otherwise, should commence their fire early, so as to ascertain *at once* when the enemies' leading ship or ships are within range, from which moment they should continue their fire, (with hot shot if it is ready, and if not with cold,) as quickly as is compatible with precision. If the approaches or channels are narrow, the fire of several guns should be concentrated on the leading ship, which ought to be sunk or blown up, but the former will be best. No time, however, must be lost, if this does not materially impede the others: so long as they are unable to show an extensive front, or to bring their broadsides to bear, so long must the fire of the Batteries be concentrated, if possible, on each ship in *detail.* By the time the enemy can engage at close quarters, they should have received rough handling, and the Casemates, with their flanking Batteries, will most probably be able to complete the rest.

This, however, is not the most formidable way (formidable as it undoubtedly is) in which the Batteries may be assailed. They may be attacked by a swarm of gun and mortar boats, at a very long range, and in a much more systematic way than the former. To meet this effectually, is to meet it in the same way. Wherever a mortar can be brought to bear upon the enemy's boats, whether from the *rear* of the Batteries, from their flanks, or from the *adjacent coast* and *heights*, there should mortars be. In this way the enemy may possibly be out-numbered, and probably beaten. But I would depend, not on this only, but on a *direct* fire also of Shrapnel Shells, projected from every gun which could be brought to bear on the enemy, and more particularly from guns of the *greatest calibre*, in order that the shells may command a sufficient range, and may contain as large a number of bullets as possible. Lancaster Guns, with such projectiles, might prove very useful.

Rockets, also, might be advantageously employed, especially in flights.

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For protection against the effects of the enemy's shells, two very necessary precautions should be taken, viz.: that the magazines are secure, and sufficiently far from the Batteries as not to injure them in case of explosion, either by their proximity, or by the quantity of powder they contain; and secondly, that the traverses are sufficient in number, and sufficiently bulky. A traverse should be placed, I think, between every pair of guns, in addition to which, there should be another in *rear* of each pair of guns, by which means ample, but not too much cover, would be given to the guns and gunners. These precautions, offensive and defensive, might, I should think in most, if not in all cases, be carried out, so as to render an attack by gun and mortar boats ineffectual, and accompanied with great loss to the enemy.

With respect to the Defence of Harbours and Coasts, it seems to me that the same error has hitherto prevailed here, as in the defence of inland fortified plans. The defenders have confined their exertions within too narrow a circle, and this applies more particularly to the employment of mortars.

In the case of a tolerably elevated coast, Mortar Batteries might be ranged along its whole crest, (as far at least as would permit of their shells reaching the probable *field* of offensive operations,) and so as to be perfectly safe from the direct fire of the shipping; and when a coast is low and flat, an epaulment in front will afford equal protection. A bay for instance (in which may be situated a harbour and arsenal), would render it impossible to pour such a *concentrated* fire upon the enemy's fleet from the crest of its coast, that I suspect it might be made too warm a situation for any amount of perseverance. In fact, here the *besieged* would have the advantage of the outer and consequently larger circle on which to operate. Bodies of Cavalry and Field Artillery might act as a guard to these Batteries so as to prevent the possibility of their being assaulted. We do not limit the number of guns and mortars in our fleets; it is as little advisable to do so in our land service.

It is unnecessary to say that no woodwork, such as wooden houses, &c., should be allowed in the garrison, and especially near the Mortar or Gun Batteries, or Magazines.

Coast Defences must be considered incomplete, if their rear and flanks are not perfectly secure against any attack which is likely to be made by the means at the disposal of an enemy's fleet. They should in all cases, and at all times, be capable of repelling a sudden attack on those points.

Before a more formidable one can be made, the enemy must equip and disembark an army. This will give time to strengthen the defences, and, if possible, the enemy's troops should always be attacked

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whilst disembarking and *before* his whole army is landed. To lose such an opportunity of attacking him, will probably be to lose the most advantageous one which may occur. He may be attacked before any considerable portion of his Artillery or Cavalry are disembarked; at the same time, he will most likely select a spot for disembarkation, at which assistance may be derived from the guns of his fleet.

These must, if possible, be opposed by Batteries of heavy guns, situated so as to command the shipping by their height above the level of the water; or, if the ground is flat and exposed, they must be at a distance of 2000 yards from the ships. The operation of disembarking should be further impeded by a heavy vertical, and, if possible, by a ricochet fire of howitzers. The latter, if horsed, will be rendered capable of changing their position should the enemy's mortars or shell guns get the range too nearly.

A strong body of Cavalry should be near at hand, and invisible, if practicable to the enemy, which should, at the proper moment, make a dash at his troops whilst forming. So long, however, as the guns of his ships are not very annoying, it will be better that the fire should be directed altogether on his troops, especially on those in the boats, leaving those who have already landed to the Cavalry, whose movements, if the ground is not very unfavourable to them, and if they are well handled, will be too rapid to admit of their being followed effectually by the fire of the enemy's ships; but, further to assist the Cavalry, an attempt may be made to draw the enemy's fire to other points.

There are few operations in war which call for more and greater qualities on the part of a General, than that of opposing the landing of an enemy's army under cover of the guns of its ships, or of effecting a landing under the fire of the enemy's Artillery; yet there can be little or no doubt, that when acting in defence of a coast or country, the former is the right opportunity for attacking.

To sum up the chief of the foregoing observations. A well-planned and efficient system of Coast Defence is daily becoming more necessary, and more admirably adapted as a system to the situation and security of this country.

All very important positions, such as Portsmouth, Plymouth, Woolwich, Sheerness, &c., should be (as they are) connected by rail with the metropolis, or with some inland and secure depôt,—Woolwich itself being, as it is that depôt. They should be so fortified and garrisoned, as, if possible, to render a successful attack upon them, impracticable. In this respect they are too often incomplete, if not entirely undefended.

The whole question of a successful defence depends upon the faci-

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lities which the Artillery of the garrison may possess for putting more guns into position, and remounting those which have been dismounted.

Ordnance commanding the greatest attainable range should be employed in Land Batteries.

Mortar Batteries should be established on many and on distant points, and may even extend (as far as the range will permit) along a coast, being merely covered with an epaulment if necessary, which, however, in the case of a somewhat elevated coast, may not be necessary. Mortars are not *nearly* sufficiently used in our Coast Defences, nor is our Artillery sufficiently heavy.

Stone works should be employed *only* as intended to act against shipping, but the main defence must in all cases consist in the *celerity* with which injured works can be repaired, and more guns, and more cover mounted and constructed. The straight-line system is a faulty one. A curvilinear one is better. A relief of from 12 or 15 to 60 feet will be best, according as ships can engage the Batteries less or more closely, and according to the character of the ground.

An attack by gun and mortar boats should be replied to by vertical fire, and by *Shrapnel Shells* of great diameter and capacity.

Magazines should be rendered perfectly secure, and should not be too close to the Batteries. Woodwork and inflammable material should be kept clear of the Magazines and Batteries.

NOTE.—The following extracts are translated from a work by M. Vauchelle, *ancien Directeur des affaires de L'Algerie au Ministere de la Guerre, &c., &c.*, and entitled *Cours D'Administration Militaire*, 3rd Volume, Chapter III., where, under the heading *De l'Artillerie*, he says:—

To the Armies, the Corps of Artillery is charged, with the distribution of the Batteries organized upon the war footing, between the Corps *d'Armee*, Divisions, and Brigades.

With the *establishment*, and with the *construction* of *all* Batteries, and with the general service of the *bouches a feu*.

With the providing the Army with arms, and with munitions of war.

With the *construction* and with the *establishment* of moveable bridges, and of passages in boats.

Section II. Chapter III., of the Engineers. To the Armies the Corps of Engineers is charged:—

With the works of permanent fortification.

With the works for the attack, and for the defence of places, and with the reconnoisances connected with those works.

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It *may* be charged, *perhaps*, (and here follows a long note on the meaning of the words *may* and *perhaps*, but as it would take up too much space to enter it here, I must simply refer all those who wish to examine this subject for themselves to the work above quoted.)

With the works of temporary fortification which the Generals of the Army, or the Generals of Divisions, judge proper to order, such as epaulments, trenches, redoubts, small forts, blockhouses, *tetes depont*, lines and entrenched camps, ditches of inundation, &c.

With the works *De Marche et D'operation*, such as the opening of passages, the construction, the establishment, or the destruction of a road, of a bridge with *fixed supports, &c.*

The *italiced* words are emphasised by myself, but the above extracts will, however ambiguous they may still leave the question, if I mistake not, shew how much more of the theory and scientific portion of their professional education is entrusted to the French Artillery to execute, than is the case in our own service. Why should this be?

I have reason to believe, that the duties performed respectively by the Corps of Artillery and Engineers, in all the European Services, are much the same as in the French Service.

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THE SEXTANT.

By Capt. H. Clerk, R. A., F.R.S

Having, when attached to the Magnetic Observatory, Cape of Good Hope, made a considerable number of observations with a Sextant to determine the Latitude, and being able to compare these observations with the true Latitude as obtained from the Royal Astronomical Observatory, in the grounds of which the former Observatory was situated, it was evident that there were very considerable errors in the instrument, and that they were of a class not generally referred to in the instructions for the use of the Sextant, but of such a magnitude as quite to impair the accuracy of the observations.

In the description of the Sextant given in a most useful work on Mathematical Instruments, by Mr. Simms, the following are pointed out as the requisite adjustments:—1st, The adjustment of the Index-Glass; 2nd, That of the Horizon-Glass, or to set it perpendicular to the plane of the Sextant; 3rd, To examine the parallelism of the two glasses when the index is set to zero, or the determination of the Index-error; 4th, To make the line of collimation of the Telescope parallel to the plane of the Sextant.

The first and last of these adjustments are seldom required in a good instrument, and when once adjusted should remain constant; any error arising from them will, however, be included in the Sextant-error, to be described further on. The second and third are liable to change, and should therefore be frequently examined, the former adjusted, the latter applied as a correction. But there are other sources of error besides the above, to which a Sextant is liable, and which, from the nature of the instrument, can only be ascertained by comparison of results obtained by observation with the truth. Amongst the principle of these are the eccentricity of the Index-arm and errors of division. In circular instruments, where at each observation three or five readings are taken at different parts of the arc, these errors are in a great measure eliminated; but in a Sextant, where only a portion of the arc of a circle is used, and only one reading taken, this is not the case, the errors must therefore be determined, and corrections applied, or the observations must be taken in such a way as to compensate each other: for instance, if observing for Latitude, observations should be made of objects at nearly the same Altitude North and South of the Zenith: if for time, then East and West of the Meridian. But it frequently happens that neither time nor circumstances permit of this combination of observations. The error and correction due to any part of the Sextant should therefore be determined. For practical purposes, it is not necessary to separate the different errors from each other, but merely to obtain the total amount at several parts of the arc, and to tabulate

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them, or lay them down in a curve: and this determination should be repeated whenever an opportunity offers, in order to see if the error remains constant; it must be remembered, that the test of a good instrument is not so much the absence or smallness of the errors, as it is, their remaining constant. A convenient instrument, by which, at any time, this error could be determined, is a great desideratum, and I understand that Professor C. P. Smyth, Astronomer Royal, at Edinburgh, has lately devised one for the purpose.

In the following table are given the altitudes and corresponding errors, as found from repeated observations for Latitude. Each of the results entered in the table is the mean of about 10 partial results. The error is the difference between the observed and true Latitude, as obtained from the Royal Observatory. In all cases the Sextant was fixed to a stand, and a more powerful telescope, than is usually supplied with the instrument, was employed. The angles or altitudes are half the angles as read off. These errors have been collected together in groups, and the mean taken—given in the lower line of the table.

For practical purposes, all that is necessary is to form from these a table of errors, and to apply them as corrections in all cases. The correction having a contrary sign to the error.

It will be seen in the following table, that at an altitude of about 34° there is no error, and that it increases with the angle each way, having a negative sign as the angle increases, and a positive sign as it decreases.

TABLE I.

SEXTANT ERRORS, DETERMINED BY OBSERVATION.

SEXTANT 2207. TROUGHTON AND SIMMS.

Altitude.	Error.	Altitude.	Error.	Altitude	Error.	Altitude.	Error.	Altitude.	Error.
° ′	″	° ′	″	° ′	″	° ′	″	° ′	″
65 0	— 33	59 37	— 30	47 37	— 18·	38 41	— 5·	32 55	+ 1·
65 3	33	58 27	29	44 27	9·	38 25	6·	32 23	4·
65 3	36	56 44	26	44 06	11·	36 04	2·	32 23	1·
61 41	25	55 57	20	43 46	12·	36 01	4·	32 22	4·
		55 41	28	43 20	13·	33 58	1·	32 21	2·
		55 17	20	43 20	12·	33 44	1·	32 21	2·
				42 47	5·				
				42 26	9				
				42 09	7·				
				42 07	8·				
				41 32	8·				
				41 11	9·				
64 12	— 32	56 57	— 25	43 24	— 10·	36 9	— 3·	32 28	+ 2

It must be remembered, that when measuring distances, or taking altitudes without an artificial horizon, the angles and corresponding errors are double those given in the table. For instance 64° 12′ corresponds to 128° 24′, as read off on the Sextant, and its error is — 64″. Again, 36° 9′ correspond to 72° 18′, and its error is — 6″, and 32° 28′ to 64° 56′, its error being + 4″.

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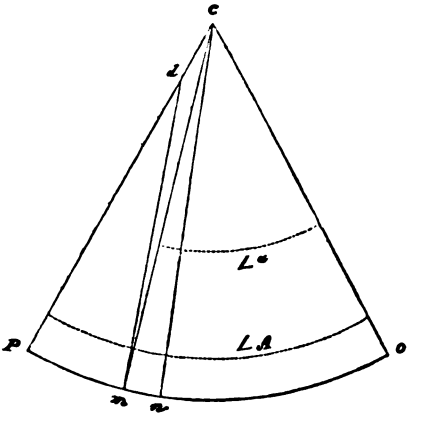
The following investigation and formula for computing the effect of eccentricity on a Sextant, were supplied to me by W. Mann, Esq., at present the first assistant at the Royal Observatory, Cape of Good Hope.



"Suppose *c* to be the centre of the divided arc, and *d* the centre of motion of the Index-arm *d m*, produce *c d* to p, and let *o* be the zero of the divisions. Suppose *d m* to be the position of the Index-arm corresponding to any measured angle a = *m c o*. Draw *c n* parallel to *d m*, and join *c m*. Then it is evident that the measured angle will, in this instance, be too great by the small angle *m c n* = *d m c*. Call ∠ d m c = θ; ∠ p c o = A; c d = δ; and d m = r. Now $\sin\theta = \frac{\delta}{r}$. sin p c m = $\frac{\delta}{r}$. sin (A—a) or $\theta = \frac{\delta}{r \sin 1''}$ sin (A—a) = φ the error produced. Call $\frac{\delta}{r.\ \sin\ 1''} = n$.

Let φ = the error produced at any angle a
φ' = " " a'
φ'' = " " a" &c., &c.

Then φ = n. sin A. cos. a —n. cos. A. sin a
φ' = n. sin A. cos. a'—n. cos. A. sin a'
φ'' = n. sin A. cos. a"—n. cos. A. sin a" &c, &c.

Combining these equations by the method of least squares, the quantities ∠ A and $n = \frac{\delta}{r.\ \mathrm{Sin}\ 1''}$ can be easily determined, and r the radius of the Sextant being known, the quantity δ (on the eccentricity) can also be obtained."

In order to apply this formula to the observations given in Table 1, we have the following data:—

φ = the error produced at any angle a.
a = the angle measured (or altitude.)
r = the radius of the Sextant = 8 inches.

From which it is required to determine the following:—

∠ A = the angle at which φ = o.
δ = the eccentricity of the Sextant.

The values of φ and a are taken from the last line of the table, and

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formed into five equations of condition. Weights being applied proportional to the number of observations of which each equation is the mean.

I.	·43523	n. sin A—	·90032	n. cos. A=	—32	No. Ob.=	4.	Wt.=	1
II.	·54537	„	—·83820	„	=—25	„	= 6.	„	=1·5
III.	·72657	„	—·68709	„	=—10	„	=12.	„	=3
IV.	·80748	„	—·58990	„	=— 3	„	= 6.	„	=1·5
V.	·84370	„	—·53681	„	=+ 2	„	= 6.	„	=1.5

First.—Multiply each equation by the co-efficient of the first term, apply the weights, and add them together.

I.	0·18943	n. sin A—	0·39185	n. cos. A=	—13·92	
II.	0·44614	„	—0·68569	„	=—20·45	
III.	1·58373	„	—1·49766	„	=—21·80	
IV.	0·97803	„	—0·71450	„	=— 3·63	
V.	1·06776	„	—0·67936	„	=+ 2·53	
Sum.	4·26509	n. sin A—	3·96906	n. cos. A=	—57·27	. . (a.)

Second.—Multiply each equation by the co-efficient of the second term, apply the weights, and add them together.

I.	0·39185	n. Sin A—	0·81057	n. cos. A=	—28·81	
II.	0·68569	„	—1·05386	„	=—31·44	
III.	1·49766	„	—1·41627	„	=—20·61	
IV.	0·71450	„	—0·52198	„	=— 2·65	
V.	0·67936	„	—0·43225	„	=+ 1·61	
Sum.	3·96906	n. sin A—	4·23493	n. cos. A=	—81·90	. . (b.)

From the two equations (a) and (b) thus obtained, it is required to find the values of A and n.

a.....4·26509 n. sin A—3·96906 n. cos. A=—57·27
b.....3·96906 n. sin A—4·23493 n. cos. A=—81·90

Multiplying each equation by the co-efficients of the other, and subtracting, we obtain:—

$$\text{n. sin A} = \frac{82{\cdot}6}{2{\cdot}309}\text{; and n. cos. A} = \frac{122{\cdot}0}{2{\cdot}309}.$$

By div. $\tan. A = \frac{82{\cdot}6}{122{\cdot}0}$ $\angle$ A=34° 6′, and $n = \frac{82{\cdot}6}{2{\cdot}309.\ \sin A} = 63{\cdot}8$

δ=n. r. sin 1″=63·8 × 8″ × sin 1″=0·002475. say 0·0025. Inch.

This Sextant had, therefore, an eccentricity amounting to 0·0025 of an inch, and at an angle of 34° 6′, there was no error.

The formula for calculation is φ=[1·80488.] Sin (34° 6′—a.)

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The following Table gives a comparison between the observed and calculated errors, using for the latter the above formula.

TABLE II.

Angle a.	Values of φ		Difference. e.	e².	Angle a.	Values of φ		Difference. e.	e².
	Observed.	Calculated.				Observed.	Calculated.		
° ′	″	″	″	″	° ′	″	″	″	″
65 3	— 33·	— 33·	0	0	42 26	— 9·	— 9·	0	0
65 3	36·	33·	+ 3·	9·	42 9	7·	9·	— 2	4
65 0	33·	33·	0	0	42 7	8·	9·	— 1	1·
61 41	25·	30	— 5	25·	41 32	8·	8·	0	0
59 37	30	28	+ 2	4·	41 11	9·	8·	+ 1	1·
58 27	29	26	+ 3	9·	38 41	5·	5·	0	0
56 44	26	25	+ 1	1·	38 25	6·	5·	+ 1	1·
55 57	20	24	— 4	16·	36 4	2·	2·	0	0·
55 41	28	24	+ 4	16·	36 1	4·	2·	+ 2·	4·
55 17	20	23	— 3	9·	33 58	1·	0·	+ 1	1·
47 37	18	15	+ 3	9·	33 44	1·	0·	+ 1	1·
44 27	09	12	— 3	9·	32 55	+ 1·	+ 1·	0	0·
44 6	11·	11·	0·	0·	32 23	4·	2·	— 2	4·
43 46	12·	11·	+ 1·	1·	32 23	1·	2·	+ 1	1·
43 20	13·	10·	+ 3	9·	32 22	4·	2·	— 2	4·
43 20	12·	10·	+ 2	4·	32 21	2·	2·	0	0·
42 47	5·	10·	— 5	25	32 21	2·	2·	0	0·

Adding all the values of e^2, we get $z\ e^2 = 168$ = the sum of the squares of the differences. The probable error of observation is calculated by the formula. $r = \sqrt{\frac{z.\ e^2}{n-1}} \times 0{\cdot}6745$, where r = probable error, and n the number of observations. Here $r = \sqrt{\frac{168}{33}} \times 0{\cdot}6745 = \pm 1.5''$ (say $\pm 2''$)

This is about what might be expected. For, the arc being divided to 10″, if the readings were taken to the nearest division, the probable error of reading might be $\pm$ 5″; but, as in all cases, the readings were taken by estimation to the nearest 5″, the probable error would only be $\pm$ 2·5″ or 3″; and, as the angles read off were double the angles required, this amount would be reduced to less than 2″. Again, the Telescope used had a power of 20, and as 1′ of arc is a quantity easily discerned by the naked eye, it follows, that with this Telescope, from 2″ to 3″ could be distinguished. By errors of observation are meant, the probable error in estimating the correct reading of the arc, and the exact contact of the objects observed, and they are totally distinct from any instrumental errors.

Though it is not strictly correct to assume the error (φ) as be-

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longing to eccentricity alone, for it, no doubt, is a combination of every possible error to which a Sextant is liable, yet, I think that in this instance, we may fairly consider that the principle cause of error is eccentricity, and that all other errors are either very small, or neutralize each other.

In order to exhibit more clearly the close accordance of the errors determined by observation with those calculated on the assumption of eccentricity, the accompanying diagram has been given, in which the errors are laid down in two curves. The calculated errors are connected by a continued straight line; the observed errors are marked thus ×, and join together by a dotted line.

The following instances of Latitudes obtained from objects North and South of the Zenith, are given in order to shew how, by a combination of observations, the instrumental errors can be eliminated, when the proper correction has not been obtained in the manner described above.

On the 26th February, 1844, at the Magnetic Observatory, Cape of Good Hope, from observations of the Sun North of the Zenith, at an altitude of 65° 0′, the Latitude obtained was 33° 56′ 40″ S.

From observations of η Argus, South of the Zenith, at an altitude of 65° 3′ the latitude was . . . . . 33° 55′ 34″ / 33 55 31 } 33 55 33 S.

The mean of these gives 33° 56′ 07″ S., as the Latitude and the half difference gives — 34″, as the error due to an altitude of 65°.

Again, on the 11th March, 1844, the sun having an altitude of 59° 37′ N., the Latitude observed was . . . . . 33 56 37 S.

And from an observation of α Crucis, at an altitude of 61° 41′ S., the Latitude observed was . 33 55 42

The mean of these gives 33° 56′ 10″ S. as the Latitude; and the half difference gives — 28″ as the error due to an altitude of 60° 39′

The Latitude of the Magnetic Observatory, determined by measurement from the Royal Observatory, is . . . . . 33 56 07 S.

The following are some points of practical importance, and will be found to facilitate the taking of observations, and ensure a great degree of accuracy.

The first and most important is the determination of the Sextant-error, described above. The next is the frequent determination of the Index-error, as it is very liable to change, especially when making observations of the sun. It should be observed before and after every set of observations. The adjustment of the Horizon-Glass

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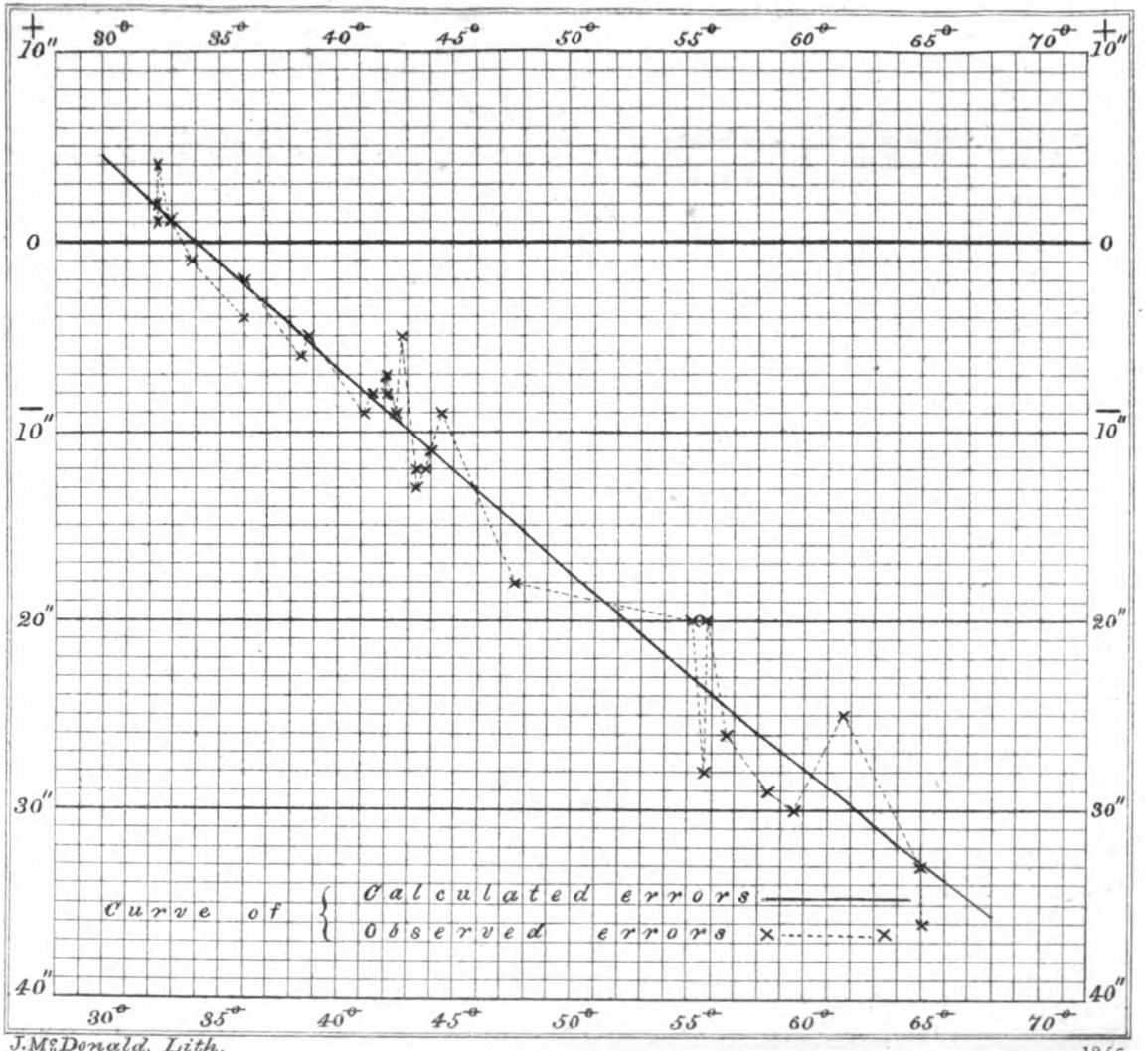

J.McDonald, Lith.

1856.

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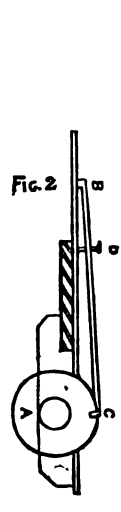
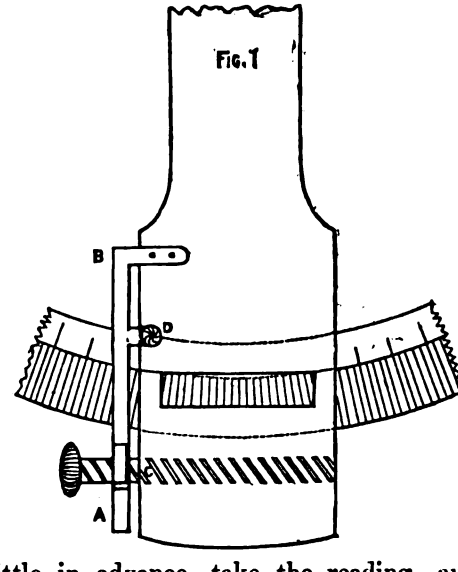
should be examined and corrected before every set of observations, and examined again afterwards to see if any change has taken place. As the method of making this adjustment, and the determination of the Index-error are described in all books of instruction on the Sextant, nothing more need be said here, except that it is always advisable to compare the sun's semi-diameter, obtained from the observations for Index-error, with that given in the Nautical Almanack, in order to check the accuracy of the determination

By means of the following simple contrivance added to the Sextant, the necessity of any reading off, except the first and last of a set, can be obviated: and this is of great importance when observing at night. It consists in fixing to the tangent-screw a small disk A, with a notch in it. From the index-arm a thin piece of steel spring plate B, with a stop at the end of it C, projects. This stop fits into the notch, by which means each revolution of the tangent-screw is distinctly marked. When observing therefore, all that is necessary is





to set the instrument a little in advance, take the reading, and note the time of the objects coming into exact contact, then take one revolution of the tangent-screw, and wait again for the time. Repeating this for as many observations as may be desired, and taking the last reading. The mean of the two readings will correspond to the mean time of observations, provided the interval be not very great. About 9 revolutions, or 10 observations, will be found a convenient number to form a set of observations. This plan being only necessary when observing for time or longitude, a small vertical screw D is added to the spring to throw it out of adjustment, when not required. As the first and last readings can be taken at any convenient time before and after the observations, all hurry and confusion are avoided. It is also better to wait for the time of two objects coming into contact, than to attempt to make the contact by means of the tangent-screw.

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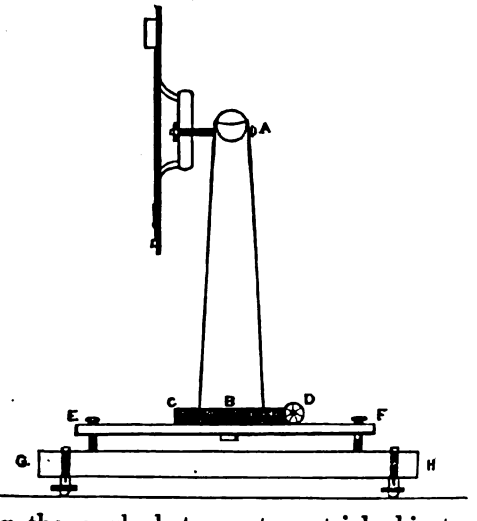
A very convenient description of artificial horizon is that made by Mr. Newman, in which the mercury is contained in a bag, and brought up into the cup by means of two screws. Care should always be taken to reverse the glasses during the set of observations, so as to obviate any errors arising from non-parallelism of the planes of the glasses, or other defects.

It is advisable to avoid using the colored glasses attached to the Sextant, as much as possible, and to use the small colored glass affixed to the eye-piece instead, as the former might cause errors in the observations.

In order to insure as great a degree of accuracy as possible, the observer should be perfectly comfortable and able to concentrate the whole of his attention upon noting the exact time of contact of the objects observed. It is therefore very essential that the Sextant should be fixed to a convenient stand, especially if a telescope of a high power be used.

The following is a description of the stand which was used when making the observations referred to above, and which was found to answer very well.



It consisted of an upright column A B, having a ball and socket at the top, and a toothed circle C D at the bottom, worked by a tangent-screw D, to give an azimuthal motion. The base of the column was fixed to a triangular plate E F, which had three footscrews, resting on a block of wood G H. The Sextant was fixed to the projecing arm of the ball, and could be clamped in any position. The object of the ball and socket was to get the Sextant into any plane when taking lunars, or measuring the angle between terrestrial objects. The block G H rested on the ground, and could be levelled by means of foot-screws. The artificial horizon was placed on a similar block of wood in front of the Sextant.

It would have been an improvement to this stand to have a counterpoise weight attached to the side of the ball opposite the Sextant. For the sake of probability, the column might be made to screw on

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to the top of the Sextant-box, the latter to have foot-screws fixed to its lower side, so that the whole could be carried in the Sextant-box.

The next point for consideration is, the best method of taking observations, either for Latitude or Longitude.

1st. For Latitude.

The most accurate plan is to take several observations before and after the meridian passage, and reduce them to the meridian by the formula and table given in Mr. Simm's book. The Chronometer-error should be obtained previously, so as to get the correct time of apparent noon. The approximate Longitude is also required to correct the sun's declination; and the approximate Latitude can be obtained from the observations nearest apparent noon, sufficiently accurate to employ in the formula for the reduction to the meridian.

The following is an example of the method of taking and calculating the observations. In this case, the readings were taken at regular intervals of 2m. from each other. The first five observations were taken of the sun's lower limb, the last five of the upper, and the glasses of the artificial horizon were reversed after the fifth observation.

The Latitude of the Royal Observatory, as given in the Nautical Almanack, is 33° 56′ 03″ South, and its Longitude 1° 13′ 55″ East.

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EXAMPLE.

Station. { Royal Observatory. / Cape of Good Hope. Date. { 22nd August, 1843. Sextant, 2207. Troughton and Simms. Apparent Time Noon—0h. 0m. 52s.

No.	Object.	Altitude.	Time.	Hour Angle.	Versed Sine.
		° ′ ″	h. m.	m. s.	
1.	⊙	87 37 55	11 53	7 52	589
2.	,,	39 45	55	5 52	328
3.	,,	41 20	57	3 52	142
4.	,,	42 15	59	1 52	033
5.	,,	42 45	12 01	0 08	000
6.	⊙	88 45 45	03	2 08	043
7.	,,	44 35	05	4 08	163
8.	,,	42 55	07	6 08	358
9.	,,	40 55	09	8 08	630
10.	,,	38 45	11	10 08	977
Sums.		81 56 55			3263
Means.		88 11 42	12 02		326·3

Barometer, = 30·15″ Thermometer, = 67·6°

Versed Sine, = 326·3 Log. = 2·51362
Latitude, = 33° 56′ log Cos. = 9·91891
Declin., = 11 56 log Cos. = 9·99051
Z. D., = 45 52 log Cosec. = 0·14404
Constant Log, . . = 9·31443
76·12″ = 1′ 16″ Log. . . = 1·88151

	°	′	′
⊙'s Declination, noon Greenwich,	= 11	56	16 S.
Variation per hour = 50·53—Correct.	=	+	01
Corrected Declination, . : .	11	57	17
Meridian Altitude, . . .	44	06	41
Co-Latitude, ...	56	03	58
	90		
Latitude, ...	33	56	02

Index-Error,		+	29
	2)	88	12	11
		44	06	06
Sextant-Error,		+	11
		44	06	17
Reduc. to Meridian.,	+	1	16
Refractn. and Parallx.,	—	0	52
True Altitude,		44	06	41

Determination of Index-Error.

on. ′	on. ″	off. ′	off. ″		
31	10	32	15		
	15		10	on. 31	14
	20		10	off. 32	12
	10		15		
	15		10	2)	58
31	14	32	12	+	29 I.E.

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2ND. FOR LONGITUDE.

A very convenient method for this determination, when the altitudes can be determined with considerable accuracy, is by observing the Altitudes of the Moon, and of a Star, or Planet near it; the time selected being when the Moon's motion in Right Ascension is the greatest. From the altitudes the hour-angles are computed, and the R. A. of the Star being known, the clock-error and R. A. of the Moon are obtained. By comparing the latter with the Nautical Almanack, the mean Greenwich time is obtained, and hence the Longitude.

Several sets of Altitudes of the Moon, and Star, or Planet, should be taken alternately, and combined together for a mean result.

The formula for computing the hour-angle is:—

$$\text{Sin}^2 \tfrac{1}{2} P = \frac{\text{Sin}\,(S-L.)\ \text{Sin}\,(S-\pi.)}{\text{Sin}\,L.\ \ \text{Sin}\,\pi.}$$

where P = Hour-Angle.
„ L = Co-latitude.
„ π = Polar distance.
„ Z = Zenith distance.
„ $S = \tfrac{1}{2}(L+\pi+Z)$

The angle $\frac{1}{2}$ P (in arc) is reduced to Time by Multiplying by 8, and making Minutes of arc, Seconds of Time, Degrees, Minutes or, dividing by 60.

The following example shews the method of observing, without reading off each time; also, the method of computing the Hour-angles, and thence deducting the Longitude.

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EXAMPLE.

Station { Magnetic Observatory, Cape of Good Hope. Date. { 24th June, 1844. Objects Observed. { ✳ α Virginis. ☽ Barometer = 30·4″. Thermometer = 60°.

SEXTANT 2207. TROUGHTON AND SIMMS.

1st Observation of ✳						2nd Observation of ✳						Observation of ☽						Remarks.
Time.			Altitude.			Time.			Altitude.			Time.			Altitude.			
h.	m.	s.	°	′	″	h.	m.	s.	°	′	″	h.	m.	s.	°	′	″	Index-Error, + 1′ 10″
9	18	56·4	102	39	25	9	40	13·6	94	45	55	9	30	09·6	92	50	15	
	19	38·4					40	54·4					30	50·8				Data from Nautical Almanack.
	20	22·8					41	36·0					31	33·2				
	21	06·4					42	17·6					32	16·0				
	21	48·4					42	59·2					32	58·4				h. m. s.
	22	33·2					43	40·8					33	41·2				✳ R. A. = 13 17 01·85.
	23	16·4					44	22·8					34	24·0				✳ Dec. = 10 21 01· S.
	24	00·4					45	04·4					35	06·4				
	24	43·6					45	46·4					35	49·6				
	25	27·6	100	16	45		46	27·6	92	23	25		36	31·2	90	27	35	☽'s Dec. = 11 25 37· S.
9	22	11·36	101	28	05	9	43	20·28	93	34	40	9	33	20·04	91	38	55	
Index-Error,				+ 1	10	Index-Error,				+1	10	Index-Error,				+ 1	10	☽'s Semi-diameter, 16′ 8″.
		2)	101	29	15			2)	93	35	50			2)	91	40	05	
			50	44	38				46	47	55				45	50	03	Horizontal Paral., 59 12.
Sextant-Error,				+	18	Sextant-Error,				+	14	Sextant-Error,				+	13	
			50	44	56				46	48	09				45	50	16	The three last are reduced to 8h. mean Greenwich time.
Refraction,				—	47	Refraction,				—	54	Correction,				+	56	28
Corrected Altde.,			50	44	09	Corrected Altde.,			46	47	15	Corrected Altde.,			46	46	44	
			90						90						90			Sidereal time mean noon, 6h. 10m. 44·69s.
	Z.	=	39	15	51		Z.	=	43	12	45		Z.	=	43	13	16	
	Π	=	79	38	59		Π	=	79	38	59		Π	=	78	34	23	Latitude, 33° 56′ 07·″ S.
	L.	=	56	03	53		L.	=	56	03	53		L.	=	56	03	53	
		2)	174	58	43			2)	178	55	37			2)	177	51	32	Approximate Longitude, 1h. 14m. E.
	S.	=	87	29	22		S.	=	89	27	49		S.	=	88	55	46	

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CALCULATIONS.

1st Observation of ✳		2nd Observation of ✳		Observation of ☽	
Log Sin (S—Π) =	9·1348159	Log Sin (S—Π) =	9·2315867	Log Sin (S—Π) =	9·2547182
„ (S—L) =	9·7171515	„ (S—L) =	9·7407280	„ (S—L) =	9·7345257
„ Cosec Π =	0·0071247	„ Cosec Π =	0·0071247	„ Cosec Π =	0·0086950
„ L =	0·0810953	„ L =	0·0810953	„ L =	0·0810953
	2) 18·9401874		2) 19·0605347		2) 19·0790342
Los Sin ½ P =	9·4700937	Los Sin ½ P =	9·5302674	Log Sin ½ P =	9·5395171
½ P =	17° 10′ 7″·8	½ P =	19° 49′ 09″·8	½ P =	20° 15′ 52″·8
✳ Hour-Angle, =	2h. 17m. 20·93s.	✳ Hour-Angle,	2h. 38m. 33·2s.	☽'s Hour-Angle,	2h. 42m. 06·93

	h.	m.	s.		h.	m.	s.		h.	m.	s.
Sideral Time Noon, =	6	10	44·69	Sideral Time Noon, =	6	10	44·69	Sideral Time Noon, =	6	10	44·69
Mean Time Observed, =	9	22	11·36	Mean Time Observed, =	9	43	20·28	Mean Time Observed, =	9	33	14·36*
	+ 1		28·71		+ 1		28·71		+ 1		28·71
	+		3·61		+		7·06		+		5·42
	+		0·03		+		0·06		+		0·04
Sideral Time Observed, =	15	34	28·40	Sideral Time Observed, =	15	55	40·80	Sideral Time Observed, =	15	45	33·22
✳ Hour-Angle, =	2	17	20·93	✳ Hour-Angle, =	2	38	33·2	☽'s Hour-Angle, =	2	42	06·93
✳ R. A. Observed, =	13	17	07·47	✳ R. A. Observed, =	13	17	17·60	☽'s R. A., =	13	03	26·29
✳ R. A. True, =	13	17	01·85	✳ R. A. Nau. Almanack, =	13	17	01·85	At 8h. Greenwich, =	13	02	42·39
Clock Fast,	...	...	5·62	Clock Fast	...	...	5·75	Hourly Variation { 135·91. } =			43·90 / 19m. 22·8

Mean + 5·68.

	h.	m.	s.
Observed Cape Mean Time,	9	33	14·4
Greenwich Mean Time	8	19	22·8
Longitude,	1	13	51·6 E.

* Corrected for Clock-Error.

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The correction + 56′ 28″ to the ☽'s altitude is obtained in the following way:—

	Semi-diameter.			*Eq. Hor. Par.*	
At 8h. Greenwich M. T.	16′	8″		59′	12″
Add Augmentation,	+	12	Cor. for Lat.	—	4
Corrected Semi-diameter,	16	20		59	08

Observed Altitude ☽	45°	50′	
	+	16	Semi-diameter.
Apparent Altitude ☽	46	06	

The correction for parallax in altitude and refraction, corresponding to the apparent altitude and corrected horizontal parallax, is taken from a Table (No. 39) in Raper's "Practice of Navigation and Nautical Astronomy."

App. Alt.	*Hor. Par.*	*Correction.*	
46° 0′	59′ 0″	40′	4″
6		—	4
	8	+	8
	Correction,	40	8
	Semi-diameter,	16	20
		56	28 Correction to ☽'s altitude.

The book referred to above contains all the necessary Tables for these calculations, together with much useful information, and is strongly recommended to any Officer of the Army intending to make observations.

The accuracy of this method depends upon the closeness with which the Hour-angles can be determined, and the correctness with which the several data in the Nautical Almanack are given. With a good set of observations, the error of the Hour-angles should not exceed about one-tenth of a second of time, this will produce an error in the Longitude of from 2 to 3 seconds, according to the rate of the moon's hourly variation in Right Ascension. It is important that the moon's variation in declination should be small, in order that any error in the assumed Longitude may cause as little error as possible in the result.

The data in the Nautical Almanack are all liable to error, any corrections found necessary must therefore be applied, and the results recalculated at some future time.

The following formula were given me by W. Mann, Esq., and will be found useful in applying these corrections, as they save the trouble of going through the whole process of calculation.

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Given an error in the Co-latitude, Polar-distance, and Zenith-distance, to find the corresponding error in the Hour-angle.

Let L = Co-latitude
Z = Zenith-distance
π = Polar-distance
P = Hour-angle.

make $\text{Sin } \theta = \frac{\text{Sin P. Sin L}}{\text{Sin Z}}$

„ $\text{Sin } \varphi = \frac{\text{Sin P. Sin } \pi}{\text{Sin Z}}$

Then
$$\delta P = -\frac{\text{Cot } \theta}{\text{Sin } \pi} \cdot \frac{\delta \pi}{15} \quad (1)$$
$$= -\frac{\text{Cot } \varphi}{\text{Sin L}} \cdot \frac{\delta L}{15} \quad (2)$$
$$= +\frac{1}{\text{Sin L Sin } \varphi} \cdot \frac{\delta Z}{15} \quad (3)$$
Or
$$= +\frac{\text{Sin Z}}{\text{Sin } \pi \text{ Sin L Sin P}} \cdot \frac{\delta Z}{15} \quad (4)$$

The quantities δ L, δ Z, δ π, being expressed in seconds of arc—δ P will be given in seconds of time.

The following is an example of the application of this formula. In the Longitude observations given above, the Declination of α Virginis was taken from the Nautical Almanack as 10° 21′ 01″ S; but we find at Page X. of the Nautical Almanack for 1844, that a correction of — 3.″ should be applied to this declination, the value of δ π in this case is + 3″., and we have π = 79° 39′. It is required to ascertain the effect of this error on the hour-angles, by formula (1.)

We have	1st Observation of *		2nd Observation of *	
	° ′		° ′	
P =	34 20—Sin	= 9·75128	39 38—Sin	= 9·80473
L =	56 04—Sin	= 9·91891	56 04—Sin	= 9·91891
Z =	39 16—Cosec	= 0·19864	43 13—Cosec	= 0·16446
Hence θ =	47 40 Sin	= 9·86883	50 37 Sin	= 9·88810
	Cotan	= 9·95952	Cotan	= 9·91430
π =	79 39—Cosec	= 0·00712	79 39—Cosec	= 0·00712
$\delta\pi$ =	+ 3 Log	= 0·47712	+ 3 Log	= 0·47712
		0·44376		0·39854
	15 Log	= 1·17609	15 Log	= 1·17609
δ P =	0·185s. Log	= 9·26767	0·167s.	9·22245

	s.
Mean Error of Hour-Angles,—	0·18
Mean observed Clock-error, +	5·68
Corrected Clock-error,	+ 5·86

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Applying this corrected clock-error to the Moon's R.A., and the Cape mean time of observation, we have

	h.	m.	s.		h.	m.	s.	
Cape mean time	9	33	20·04	☽'s R.A.	13	03	26.29	
		—	5·86			—	0·18	
	9	33	14·2		13	03	26·11	cor-
responding to mean Greenwich Time	8	19	18·0					
							s.	
Longitude	1	13	56·2	differing only			1·2	from the Longitude given in the Nautical Almanack.

This method of determining the Longitude is recommended when the altitudes can be observed very accurately, with an artificial horizon on shore for instance; but on board ship, when the sea horizon is used, the Lunar method is probably the best.

Another method of determining the Longitude, is by observing the moon's meridian altitude, when her motion in declination is at a maximum. The Latitude being known, and comparing her declination as determined by observation, with the Almanack, in a similar way to what is done in the case of her Right Ascension. But this method is not so accurate as the former, as it requires the Latitude to be known very exactly.

Although in Military Surveying the large Sextant is seldom used, nor is any great degree of accuracy necessary, yet there are many occasions when an Officer of the Army or Navy may be desirous of determining his Latitude and Longitude as closely as possible. The object of this paper is, therefore, to point out certain errors to which all Sextants are liable, and the importance of determining them; also, some points, by attention to which, accurate results may be ensured.

The same remarks apply to Circular Instruments as well as to Sextants; and, although the former are more accurate in construction and principle than the latter, yet, it must be remembered, that the latter have the advantage of portability, combined with large dimensions. A circle, 8 inches radius, would be rather an unwieldy instrument for a travelling observer, and if the circle be reduced to convenient dimensions, the divisions of the arc are also reduced, and cannot be read off with the same precision.

With a good Sextant, whose errors have been accurately determined, a powerful Telescope, and convenient Stand, the Latitude should be obtained to within 2 or 3 seconds of arc, and the Longitude to within 3 or 4 seconds of time.

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Extracts from the Memoir of Baron Alexander de Senarmont, Lieut.-General of the French Army. Translated from the French of General Marion.

By Capt. W. H. R. Simpson, R.A.

The following extracts from the life of General Senarmont may not be uninteresting to Artillery readers, as shewing the disposition made by him of the French Artillery, both as regards its independant action, and concentration of its fire.

Alexander Antoine Hureau de Senarmont, General of Division, Commanding-in-Chief the Artillery of the Army of Spain, Baron of the Empire, &c., &c., was born at Strasbourg on the 21st April, 1769. He entered the Military College of Vendôme in 1780, after which, he was received as Cadet in the College of St. Louis, at Metz, in 1784, was appointed 2nd Lieutenant in the Regiment of Besançon in 1785, 1st Lieutenant 1791, and 2nd Captain 1792.

Passing over the early part of his career, during which, he served with distinction in Campaigns from 1792 to 1799. Senarmont was promoted in 1806 to the rank of General of Brigade, and commanded the Artillery of the 7th Corps, at the battle of Eylau, in February 1807.

At this battle he contributed greatly to the victory. The following is his report:—

Report of General of Brigade Senarmont, on the operations of the 7th Corps, at the battle of Eylau, to General Songis, Inspector-General.

On the 29th January, 1807, the 7th Corps of the Grand Army, by order of Marshal Augereau, broke up its cantonments, which it occupied between the Hareu and the Vistula, and the boundaries of the circle of Plock, in readiness to move. The 7th of February the Corps marched on Eylau, and occupied a position in front of the town. The Artillery of the two divisions marched together in rear.

On the 8th, about 8 o'clock in the morning, each division of the Army formed up by battalions, Marshal Augereau (by order of the Emperor) posted himself in front of a division of Infantry, near and to the right of the town of Eylau. I disposed of all the Artillery under my orders in the following manner:—

Four 8-Pounders, and one Howitzer, served by Captain Chopin's Company, formed a battery to the right of a burnt house situated on

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the reverse of a tolerable height; on the left of this battery I placed two 8-Pounders, commanded by Captain Grosjean, and reinforced this battery by two 8-Pounders, two 4-Pounders, and one Howitzer. The batteries together then consisted of 12 pieces, the whole of the Artillery of the 1st division, and was commanded (under my orders) by Chef de Bataillon Dubois.

These batteries being the centre of the enemy's fire, concentrated from a large circle, suffered very severely. In a moment, Captain Benoit was killed by a round shot. His 2nd Lieut. Vacquin, a young Officer of great promise, had his right arm carried away, and Lieut. Goujon was severely wounded.

The Infantry, also, concealed behind a rising ground, suffered heavily from shot, which fell short of the battery.

All these circumstances combined, determined me to propose to Marshal Augereau placing my batteries in a plateau a little lower in height, and situated at 200 toises (400 metres) from the enemy; and that the infantry, who had the order to attack, should follow this movement. The Marshal having approved of my proposition, I put it into execution with all speed, and sent orders to the Artillery of the 2nd division to replace me immediately in the position I was leaving, so as to be in line with me, *and to crush the enemy by a concentrated fire of* 19 *pieces of Artillery.*

The charge of the Infantry having been unsuccessful, they were pursued in their retreat by a large body of Cavalry, which put them in disorder. The battery being in danger of being surrounded, I was obliged to execute a retrograde movement of some paces. This was done without disorder, although the gunners of the last pieces were engaged with the enemy's Hussars, some of whom they killed. The enemy were repulsed, and we retook the plateau, which we held until two hours after dark.

I ought to mention in praise of the Artillery, that in this action, one of the most bloody on record, the youngest officers and gunners showed a coolness and courage, not always found, even in old soldiers.

Head-Quarters Albrechtsdorf,
12th February, 1807.

Report of General Songis, First Inspector-General of Artillery, to the Emperor, 16*th February,* 1807.

In all the affairs which have taken place since the renewal of hostilities, at the battle of Eylau above all, have the Artillery distinguished themselves; its considerable losses attest its bravery, and the appearance of the field of battle, proves how murderous has been its fire, and that it was directed with that precision and coolness which belongs to true courage.

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Seventh Corps. In the affairs of the 26th (passage of Wkra) and 24th of October, (battle of Gobymin) the Artillery behaved with its usual bravery. It had to resist a fire much superior to its own, and to overcome obstacles of ground almost insurmountable.

At Eylau, Officers, Non-Commissioned Officers and Soldiers, covered themselves with glory; exposed to a fierce and murderous fire, they shewed a coolness and courage beyond praise. Your majesty will see, not without pleasure, that in these affairs the Artillery have occupied their positions without a man flinching for a single moment

I cannot praise too highly the conduct of General of Brigade Senarmont, whose talents and services are known, I ask for him the rank of Commandant of the Legion of Honor.

The 3rd of March following, Senarmont received the reward so well merited.

Battle of Friedland, 14th June, 1807.

The Russian Army, who were situated on the right Bank of the Aller, were seeking to force a passage, in order to make a junction at Königsberg with the Prussian troops; and General Bennigser, Commanding the Russian Army, had already taken up a position on the left bank in front of Friedland.

In the morning, the Corps d'Armée of Lannes, very much inferior in numbers, sustained against this advanced guard an unequal contest, preventing, by skilful manœuvres, the enemy marching on Königsberg, and giving time to the other Corps of the French Army to arrive at the field of battle.

The Russian line, intersected by a deep ravine, formed an arc, of which the two extremities rested on the Aller; as soon as Napoleon arrived, he resolved to profit by this bad disposition.

Marshal Ney, who commanded the right wing, received orders to drive back the left wing of the Russians on Friedland, and after having taken the town, to throw forward the right wing with Lannes and Mortier at its head.

This manœuvre was executed; but in wheeling, the French troops were very much exposed to the fire of the Russian batteries established on the other side of the river. These batteries took them in flank; one amongst others established on an advanced hill, almost surrounded by a detour of the Aller, caused frightful ravages.

A movement of hesitation announced, that under this murderous fire, the courage of the soldiers began to waver; Napoleon detached Dupont's division to the help of the 6th Corps; already it was too late, for Ney's line was in confusion. Soon the Russian Imperial Guard, deploying with impetuosity from the ravine, where it was in ambuscade, joined the struggle. The disorder of the French Infantry was at its height. Bagration gained ground in the breach made by his Artillery. The situation became critical.

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During this disaster, the battery of Dupont's division, commanded by Capt. Ricci, (since Marechal de Camp,) opened fire, and protected by its discharges, several regiments were enabled to form at the extremity of Ney's line. It was but just in time, for at the moment when it fired its first shots, the Russian Cavalry were already amongst the gunners. General Senarmont was in the midst of the guns, "Wonderful," said he, remarking the address and the cool bravery of the gunners, "it is like manœuvering on parade." Yes General, replied Capt. Ricci, "but see how many pieces the Russians have against us." "Hold your own for a while, you shall soon have reinforcements," said the General. His resolution is taken.

He immediately hastens to his Corps d'Armée, and with the consent of Victor, but in spite of the remonstrances of the Generals of divisions, he unites all his Artillery, composed of 36 pieces, unlimbers, and sends the horses behind the hill, occupied by the 1st Corps. The Artillery opened fire at 400 metres from the enemy; after five or six salvos, it approached to 200 metres, and again commenced a quick fire.

The Russians, surprised by this combination, replied in vain, with their batteries disposed throughout their whole line; a few minutes only sufficed to concentrate on a single point a deluge of fire. The batteries on the right bank of the Aller were each crushed in succession; the battery amongst others, which, at the commencement of the action, had made such cruel ravages in our ranks, had in a moment all its horses killed, and guns dismounted. We then commenced a plunging fire into the midst of the Russian troops, who were crowded in the defile in front of Friedland. The destruction was frightful.

Napoleon had followed attentively the various phases of this furious combat, he was stationed near the 1st Corps. Fearing that Senarmont would compromise himself, he sent his Aide-de-Camp Morton to inquire why he advanced so far. "*Leave me to do it with my gunners,*" replied the General, carried away by his ardour, "*I will reply to all.*" When Morton returned, Napoleon had already judged of the effect of the firing, and said, smiling, "These Artillerymen are hot headed fellows, leave them alone."

Bagration, obliged to make a retrograde movement, took his troops between the Aller and the Ravine, his line could not be turned, but his front thus reduced, became less dangerous to us, and his masses deeper, rendered our shots more destructive. Senarmont advanced boldly to 120 metres from the Russians.

Their guns were in numbers equal to ours, and many of them took us obliquely. Senarmont, however, gave orders not to fire at them, but only on the columns with case shot.

The masses cut up by this terrible fire were replaced by others, who came up only to suffer the same fate with heroic courage. At last

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the Cavalry moved to charge the battery; immediately Senarmont changed his front, and swept away the Cavalry with two discharges of case.

From this moment the battle was won.

We see that the success of this battle was owing to the management of the Artillery by Senarmont. The records of Artillery cannot mention a more glorious action. Thirty-six guns did what, twenty thousand men under Ney and Dupont's division as well failed to do, and what, perhaps, the three divisions of reserve under Victor would not have done. When we see with what courage the right wing of the Russians formed in columns, resisted the victorious army after their retreat was cut off, we cannot help thinking that victory would have been impossible to any other arm but Artillery.

General Senarmont advanced, unsupported in front of the other troops, and obtained a brilliant success.

This is the first time that Artillery acted so independently of other arms. Here it sufficed by itself.

From all the information we can gather, it appears that Senarmont previously proposed the plan to the Emperor, of employing the Artillery in this manner at the critical moment of the day. Napoleon was not ignorant of the great effect produced by a concentration of Artillery, but he did not anticipate so decisive a result; and seeing the battery of thirty pieces of reserve advancing from 400 to 200 metres, he thought for a moment they were lost. The fire of case of this battery, at the distance of 120 metres, Senarmont's change of front to resist Cavalry, ought to fix the idea of this great Captain on the progress and tactics of Artillery.

Napoleon, in fact, employed after the victory of Friedland, much more considerable bodies of Artillery than in his previous campaigns, and struck the decisive blow in all his great battles, by launching on the principal point of the enemy's line, the fire of an immense number of guns.

War of Spain.—Campaigns of 1808—9—10.

On the 26th August, 1808, Senarmont received the order to march into Spain with the 1st Corps d'Armée. The 30st October following, he was created Baron of the Empire, with a revenue of 10,000 francs in Westphalia, and soon after chevalier of the order of "la couronne de fer."

On the 29th October, 1807, Napoleon concluded a treaty of occupation with Spain, and of the partition of Portugal. The shameful scenes at Bayonne in May, 1808, and the abdication of Charles the IV., had given to Joseph the title of King of Spain, and had opened Madrid to him. But Dupont's disaster at Bayleu, (19th July,) the check and capitulation of Junôt in Portugal, (30th August,) the impolitic retreat of Joseph on Madrid, together with the insurrection

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of the Spaniards, and intervention of the English, had ruined the affairs of the French in Spain.

Napoleon, who, at the conference of Erfuth, (27th September, 1808,) had obtained the assent of the Emperor Alexander to his projects on Spain, directed there an imposing force towards the end of 1808, of which he took the command himself. The army was recruited by a conscription of 160,000 men. Napoleon arrived on the 3rd November at Bayonne, the 9th at Vittoria, and on the 10th November all the Spanish Munitions of War fell into the hands of the French at Burgos.

At Burgos, Senarmont passed his Artillery in review before Napoleon, it was the first time he had seen the General in command of the Artillery of the 1st Corps, which had served so brilliantly at Friedland. "General, you have a fine troop here" said he,—"As good as fine sire." "I know it, and remember their services; I fancy I still hear your fierce and terrible cannonade at Friedland. Do you know you made me feel for a moment what fear was," replied the Emperor.

Capture of Madrid, 3rd December, 1808.

Report of General Senarmont relative to the Artillery of the 1st Corps on the Attack on Madrid.

The army continuing its march, arrived on the 2nd under the walls of Madrid; the attack His Majesty delayed until the following morning. The 1st Corps had charge of the part comprised between the gates Saint-Barbe and Atscha, and consequently had to force the gates of Alcalla and Ricollets.

The first that of Alcalla, defended by an intrenchment, palisaded and armed with four guns, was very difficult of access, on account of the wall of the park of Buen Retiro, occupied by the enemy, which was loop-holed along its whole length, bordering the road. This road formed a bend, and the gate could not be seen without turning the angle, it would therefore be necessary to take Retiro first. His Excellency Marshal Victor, by order of His Majesty, drew up a plan of attack, which was executed with the greatest exactness and intelligence.

It was decided to make a breach in one and even in two places if necessary in the walls of Retiro in the side at right angles to the road; that then the Infantry were to occupy the park, while the Artillery should march along the road to attack the front, and to place pieces on the flanks so as to take the gate if possible in reverse. After being masters of the gate, the Rue d'Alcalla might be swept, and lodgements made in the houses successively as the troops advanced.

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For the execution of this project, the General of Artillery established:—

1st. In front of a white house, situated on the left of the Alcala road, (looking towards Madrid, and at 200 metres from the walls of Retiro,) 6 guns of the 2nd Division, (four 8-Pounders and two Howitzers,) commanded by Chef d'Escadron Sezelle. The object of this battery was to break open the gate.

2nd. A similar Battery composed of four 8-Pounders and two Howitzers, close and to the left of the road; the object of which was to enfilade the walls of Retiro, and to throw shell into the entrenchment of the Alcala Gate. The battery was commanded by Chef d'Escadron Marcillac.

3rd. On the right of the road, 2 Batteries of three 8-Pounders and 1 Howitzer, commanded the right by Lieutenant Hervilly, and the other by Captain Cazeau.

These two batteries fired on the walls of Retiro parallel to the road, and also on the Alcala Gate.

These dispositions made, the attack commenced, the pieces well served, kept up a hot fire; the breach was made in three quarters of an hour. The Retiro was occupied by our troops. The Artillery then advanced to 60 toises, (120 metres of the gate); three 4-Pounders and one Howitzer were taken to the left flank on the edge of the lake of Retiro. The enemy abandoned the gate, and immediately the gunners, with the same ardour that they had hitherto displayed, destroyed the palissades, turned the intrenchments, and filled up the ditch for the passage of Artillery.

An 8-Pounder opened fire, and immediately the enemy who manned the intrenchments of the Rue d'Alcala commenced a sharp fire, the entrance of the gate was obstructed in a moment by the corpses of men and horses, and it was truly an act of heroism on the part of the gunners to advance as they did.

They advanced step by step, and at the time when the fire ceased, the Artillery, (reinforced by some more 4-Pounders, which the General held in reserve,) occupied the following positions:—

Nine guns of Horse Artillery of the 3rd Division in the Rue d'Alcala, at the entrance of Praolo.

In front of the Rue St. Jerome, and enfilading Praolo, 7 guns of the 2nd and 3rd Divisions.

On the platform of observation two 4-Pounders; at the angle of the Palace of Buen Retiro one 8-Pounder.

These different points were reinforced at day break, and calibres of some of the guns changed as well as their position.

While this was going on, the Artillery of the 1st division attacked the Ricollets Gate with four 8-Pounders, two 4-Pounders, and two 24-Pounder Howitzers.

The four 8-Pounders commanded by Capt. Varenne, placed on the

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left of the gate, took it in flank, whilst the four 4-Pounders and the Howitzers, under Capt. Viallet, took it in front. The gate was carried, and the Artillery entered at the breach on the Rue d'Alcala, and united itself with that of which we have already spoken.

Such is an account of the manœuvres of the Artillery on the 3rd December. All the movements were constantly directed by the General of Artillery, and executed by the superior officers Bernard, Sezelle, and Marcillac, who deserve praise for the exact execution of the orders given to them.

Loss.—Lieut. Dressens, Serjeant Klein, 6 gunners, and 22 men wounded. Ammunition expended 2,557 rounds.

Two summonses of surrender were addressed to the authorities of Madrid, which were received with indignation; at the 3rd summons, however, after a tumultuous council, the regular troops left, the populace dispersed, the insurrectionary junta retired to Aranjuez, and the French were put in possession of all the military posts.

The Emperor loaded with praise, General Senarmont, whose vigorous attack had materially contributed to this fortunate result, and named him General of Division on the field of battle.

On the 28th July, 1809, the French Army met the Spanish Army of Estramadura, consisting of 36,000 men, the Legion of Robert Wilson of 4000 men, and the English Army of 24,000 men in position near Talavera. The 1st Corps (Marshal Victor) had only 25,000 men; the 4th Corps, (Sebastiani,) who had not yet arrived in line, amounted to no more than 16,000 men.

Joseph and his Major-General, Marshal Jourdain, wished to wait for the arrival of Marshal Soult, to establish equality of numbers, and place the Allied Armies in a critical position; but at the instance of Marshal Victor, it was decided to act immediately. The French failed in their attack, badly arranged against a very strong position and superior numbers.

* * * * * * *

Battle of Ocana, 18th November, 1809.

The French Army, who were advancing to meet that of Spain, found it ranged in order of battle.

The right wing and all the Cavalry were deployed in front of a gentle slope. The centre formed in deep columns, was in front of the town of Ocana; the left was behind a ravine, not deep on the side of the town, but which towards the left wing became a perfect precipice.

About 40,000 Infantry, 7000 Cavalry, and 60 pieces of Artillery were in line.

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The French had but 24,000 Infantry, 5000 Cavalry, and 50 guns. Marshal Soult commanded the French Army, the Artillery was commanded by General Senarmont.

The Marshal resolved to attack the right and centre of the Spaniards, and only to check the left wing opposite the ravine.

General Sebastiani's Cavalry, and the Corps of Generals Leval, Gerard, and Dessolles, manœuvered to turn the right. The latter stretched his troops on his right to line the top of the ravine to keep under the fire of the riflemen, with which it was filled, and keep in check the enemy's left wing.

These dispositions were completed by 11 o'clock; then Senarmont uniting 30 pieces of Artillery, took them to the edge of the ravine, and opened fire on the centre of the Spanish line.

To protect this battery against the Sharpshooters in the Ravine, six guns directed on them their fire, whilst six others placed more to the right swept the approach which it enfiladed.

During this cannonade, the Spaniards seeing their right wing threatened executed a change of front, throwing the right back.

And from the centre of their line sixteen guns opened a murderous fire on the columns of Leval and Gerard, who were advancing on the right.

To reply to this fire a French battery advanced at a gallop to a small eminence, which was near and established a counter battery.

The Spaniards were undisciplined and badly commanded, but brave and more numerous. They took up the offensive, and redoubling their fire, they dismounted two French guns. Marshal Mortier and General Leval were wounded. The Spanish line advanced, and the first French divisions gave way and fell back.

But the battery on the centre had produced its effect. Case shot had driven the Sharpshooters from the Ravine. The large battery had forced the centre of the Spanish Army, and permitted General Dessolles to march on Ocana. Then General Senarmont directed all his fire on the right wing of the Spaniards, which, owing to their change of front, was enfiladed. This murderous fire, which extended along the whole line, stopped the success of the Spaniards. Marshal Mortier had time to bring up his second line across the interval left by the first.

Before night all the military equipage, 5000 horses, 45 pieces of ordnance, 30,000 muskets, and 26,000 prisoners, had fallen into the hands of the French.

Who will not admire the beautiful combinations of Senarmont? He knows that when the enemy's right is threatened, they will be obliged to change their front, and throw their right back. Then, instead of making a direct attack, he commences a fire on the enemy's centre, which throws them into disorder; quiet then on that side, he is enabled to execute a change of front, which allows him to enfilade the whole Spanish line.

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But, if the combination is good, we must also admire the execution. He might be annoyed by Riflemen in the Ravine, under most circumstances, it would not be the part of Artillery to drive them out, but here to make sure of success, and not to fail through any failure of others; with Artillery itself Senarmont protects his battery against the Riflemen which the ground favoured. That the action might last the shorter, he spares no shot, and obtains perfectly his object.

* * * * * * *

General Senarmont lost his life at the siege of Cadiz in October, 1810, whilst inspecting a new battery, he was struck by an 8-inch shell, and immediately expired, at the age of 41 years.

We need not point out here how much the tactics of Artillery owe to Senarmont. We have seen already how the success of his bold manœuvres could alter the opinions of the Emperor himself. We will content ourselves by giving one final example, (from a work by Commandant of Artillery Mazé, entitled "Artillerie de Campagne en France.")

"This arm (the Artillery) become more manageable, was required to become more available, and to act with more independance. Its reserves better distributed permitted it to enter the action at the critical moment. Its sphere of action increased, but it still hesitated to profit by all its advantages. Considered so long as a purely accessory arm, it remained ignorant of what it could do by itself.

"It required a skilful man, and one gifted with military genius, to draw the Artillery into the new and glorious sphere which it ought to fill. This man was Senarmont. The bold manner in which he employed his Artillery at Friedland, and the great results which were the consequence astonished even Napoleon. And from this epoch the Emperor considered Artillery as being capable of being employed independantly, and even in certain cases to obtain a particular end as a principal arm. We need only cite for example the great battery at Wagram, and the skilful manœuvres of General Drouot, at Leipsig, Haneau, &c."

At the critical moment of the battle of Wagram, the want of a vigorous effort on the part of Artillery recalled to Napoleon the bold manœuvres at Friedland. "Ah, if I had but Senarmont here," cried he. What could be higher praise than this involuntary remembrance.

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An Account of some Experiments made by direction of the Ordnance Select Committee.

Communicated by CAPT. C. W. YOUNGHUSBAND, R. A., F.R.S.

The following brief account of some experiments recently carried on by the Select Committee, relating principally to ordnance of different manufacture and construction, will, it is hoped, be found interesting to Officers of the Corps.

Fairbairn's Experimental Cast Iron 24-Pounders.

Six experimental 24-Pounder Iron Guns, each 9 feet 6 inches in length, and 50 cwt. in weight, were cast under the direction of W. Fairbairn, Esq, by the Bank-Quay Foundry, during the months of August and September, 1855; the greatest possible care was used in selecting the strongest and purest metal, and in every process connected with the casting. The guns were lettered A, B, C, D, E, and F.

A.—Cast from the Bank-Quay Foundry Mixture.

B.—Cast from pig iron, re-melted once, and then run into the mould in the usual way.

C.—Cast from the Bank-Quay Foundry Mixture, run from the Cupola, and re-melted by de-sulphurized coke.

D.—Cast from the Bank-Quay Foundry Mixture, under a dead-head pressure of 13 feet 9 inches.

E.—Cast from pig iron, re-melted once, and then run into the mould under dead-head pressure of 17 feet 3 inches.

F.—Cast from the Bank-Quay Foundry Mixture, with a core in the centre. The great heat caused the iron core to adhere to the metal, and the cast was consequently a failure.

The Guns marked A, B, C, D, and E, were guaged, examined, and proved in the Royal Arsenal on the 9th and 23rd October, 1855, and then removed to the Butt in the Marshes for experiment. The experiments were commenced 30th November, and were terminated 21st December, 1855.

The charges used were as follows:—

No of Rounds.	*Powder.*	*No of Shot.*	*Wads.*
5	8 lbs.	2	2
5	8 „	3	2
5	10 „	3	3
2	10 „	4	4 C burst.
3	10 „	4	4
5	12 „	4	4
2	12 „	5	5

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Cylinders averaging 144 lbs. in weight, or equal to 6 shot, were here substituted for the shot, and the experiment continued:—

No. of Rounds.	*Powder.*	*Cylinder.*	*Wads.*
2	12 lbs.	144 lbs.	1
2	14 „	144 „ and 1 shot.	1 D burst.
1	14 „	144 „ do.	1 B burst.
1	14 „	144 „ do.	1 A & E burst.

The severe test which these guns stood before bursting, affords a satisfactory proof of the value of good cast iron as a material for ordnance, provided the metal be properly prepared, and judiciously treated during the process of casting. It will be observed that C gun burst at a comparatively early stage of the trial, this appeared to have been caused by fragments of shot broken by contact with each other within the bore. On commencing the experiment, the guns were placed on the ground, and their muzzles supported by blocks of wood as is usual in the proof of ordnance. Sods of earth, and holes dug in the slope of ground at the rear, somewhat checked the recoil. After a time, when the guns were heavily shotted, the recoil became so great that other means for checking it became necessary; beams of wood were driven horizontally into the bank, and the button of each gun brought against the end of a beam; the beams were, however, soon split. Heavy piles of timber were then driven into the ground in the rear, and supported by cross beams, this formed a bulk-head, which effectually resisted any further recoil.

The number of pieces into which each gun burst varied from 15 to 24, besides many small fragments: large pieces were thrown considerable distances, one piece fell 700 yards to the right. In every instance but one, when the guns burst the shot, or cylinders and shot, were driven into the Butt as usual. In the case of A, the exception alluded to, one-half of the cylinder was found among the fragments of the gun. It appeared evident that this gun had burst before the *inertia* of the charge had been completely overcome, and that the cylinder was broken by contact against the fracture of the bore.

It will be seen that A and E guns stood the greatest number of rounds. From an examination of the granular character of the fragments of both guns, it was concluded that the metal of E gun was the best; in this opinion Mr. Fairbairn concurred; he attributed the closer and stronger grained metal, partly to the re-melting of the iron, and partly to the great length of dead-head, 17 feet 3 inches, and it will be admitted that both stood an exceedingly severe test.

A Wrought Iron 68*-Pounder Gun of* 95 *cwt., length* 10 *feet.*

This Gun was manufactured by Messrs. J. and G. Walker, Gospel Oak Works, and by these gentlemen placed at the disposal of the

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Ordnance Select Committee, for the purpose of "testing the capabilities of wrought iron with heavy projectiles."

The Gun was fired at the Proof Department, Royal Arsenal, 11th July, with the usual proof charge of Cast Iron Guns of this nature, viz.:—28 lbs. powder, 1 shot, and 2 wads; it burst at the first discharge, breaking into six parts; the fracture was similar to that in many cast iron guns, as regards the complete opening of the piece from the trunnions to the extremity of the button; the fracture exhibited a decidedly crystalline structure, similar to the fracture of cast iron, and without any appearance of the fibrous qualities of wrought iron; the fractures exposed to view, in several places, the imperfection of the forging, there being an entire want of union in some parts of the metal. Some fragments, both of the interior and exterior, were submitted by Mr. Abel to chemical examination, who reported that the metal did not differ in its chemical constitution from good fibrous wrought iron; the crystalline structure exhibited by it, is therefore not due to any chemical change brought about by the repeated exposure to heat. It seems probable that reiterated exposure to heat and regular vibration had gradually converted the wrought iron, of which the gun was composed, from the fibrous to the crystalline state; and thus the change in the physical structure of the metal was effected.

Malleable Iron 9-Pounder Gun, proposed by Mr. Dundas.

The method of construction is thus described by Mr Dundas:—

The gun is formed of staves or bars of small dimensions, which, after being rolled to the requisite curve and thickness, are accurately dressed on the fitting edge, and hooped together with temporary rings. The tube thus formed is turned on the outer surface, permanently dressed and flattened on the sides, and bored out in the inside; the hoops being made slightly smaller than the diameter of the staves, and expanded by heat before being put on, the whole of the parts will be drawn together into perfect contact. In this state, and while the tube is open at both ends, the turning externally, and the boring internally, is effected. The breech end is stopped by a plug, of conical or other form, inserted from the mouth, and by a simple arrangement made capable of removal, so as to render the gun unserviceable in case of capture.

Mr. Dundas was of opinion, that the strength of a gun formed in this manner would be "evidently at a maximum"; that, by forming the longitudinal bars of only sufficient dimensions to afford requisite fitting edges, and the hoops presenting the fibre of the metal in the direction of the circumference of the gun, the greatest strength with the least weight would be obtained. After detailing the advantages

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in manufacture that would be derived from making all the parts of small dimensions, and therefore securing perfect soundness in each; also, the advantage of being enabled to employ different contractors for the several parts, which parts, after being tested, would be fitted together in Government Departments, and the facilities thus afforded of getting guns manufactured in great numbers; he contended that a gun of this construction would never become entirely unserviceable, for new staves could be at any time fitted with the old rings, and the gun rebored to the desired calibre; or even the staves replaned to more acute angles, to form a smaller bore.

The 9-Pounder Gun made by Mr. Dundas for trial, was formed with double layers of hoops or rings, the outer layer so placed as to cover the joints of the lower layer; this gun was tried in comparison with the 9-Pounder *Iron* Gun, and the 9-Pounder *Brass* Gun of the Service; the three guns were fired with similar charges and elevations, and the same number of rounds; the particulars of the experiment are as follows:—

Dundas's 9-Pounder *Wrought Iron*, weight 18 cwt., length 7 ft. 6 in.
Service 9-Pounder *Cast Iron*, „ 17 „ „ 5 „ 6 „
Service 9-Pounder *Brass*, „ 13½ „ „ 6 „ 0 „

As proof, 2 rounds were fired from each, 8 lbs. of powder, 1 shot, 1 wad.

Then for comparative trial—

86	rounds,	3	lbs. powder,	1	shot,	0	wad.
26	„	4	„	1	„	0	„
5	„	5	„	1	„	1	„
5	„	5	„	2	„	1	„
3	„	6	„	2	„	1	„

At this stage of the experiment Dundas's Gun burst; the iron gun was fired 107 rounds additional, with the last charge, 6 lbs., 2 shot, 1 wad, it then burst; the brass gun was fired 171 rounds more than Dundas's, with 6 lbs. powder, 2 shot, and 1 wad, when it was found unserviceable from bulging at the muzzle.

During the progress of the experiment frequent examination was made of the state of the guns. On the first day, after the proof charge was fired, Dundas's gun was subjected to the water proof; water made its appearance in two or three places behind the trunnions. Mr. Dundas, who was present at the time, was of opinion that this did not detract from the strength and toughness of the gun. On a subsequent examination, after the first 50 rounds had been fired, it was observed that the escape of water was somewhat less than after the proof some days before, the opening having probably become closed by rust. After the 20th round, with 3 lbs. powder, (22nd, including the proof,) it was found that a separation had commenced between two of the rings at the vent-field astrigal; this separation, slowly, but perceptibly and gradually, increased. At the 26th round, with 4

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lbs. of powder, (114th in all,) the parting was just sufficient to admit the blade of a penknife; the searcher discovered a corresponding parting in the interior of the bore. At the 3rd round, with 5 lbs. of powder, and 2 shot, (122nd in all,) the separation had increased to ·2 inch. At the 3rd round, with 6 lbs. powder, (127th in all,) the breech was torn nearly off, a large opening having been made at the right side; the vent-field, and also some fragments of iron, were blown some distance to the rear. One of the rings was carried away entirely, and could not afterwards be found.

The Service Iron Gun showed no change during the progress of the experiment, except an enlargement of the vent; it was destroyed at the 232nd round.

The Service Brass Gun showed no change except enlargement of the vent, and indentation of the bore by the shot; it was rendered unserviceable at the 296th round.

It will be borne in mind that the charges fired during the latter part of the experiment, were greater than the usual service charge.

Krupp's Steel Gun.

As far back as the year 1847, it appears that Mr. Krupp, a cast steel manufacturer of Essen, in Prussia, urged upon the attention of the Prussian Government the durability and efficiency of cast steel as a material for ordnance. In August of that year, a 3-Pounder made of cast steel, and encased in a jacket of cast iron, was transmitted by Mr. Krupp to Berlin for trial. Several deficiencies, which then existed, having been made good, the gun was in July, 1849, submitted to some very severe tests. The following is a general description of this gun:—

The main body of the gun was formed of cast steel, cast solid, then forged, and afterwards bored; its weight, after boring, was 229 lbs. At the mouth of the chase the thickness of the metal was $\frac{3}{4}$ inch, and at the breech $1\frac{1}{4}$ inch; the exterior of the 1st and 2nd reinforce was cylindrical, and of the chase conical; the diameter of the bore was 2·86 inches, or that of a 3-Pounder. This formed the barrel of the gun; it was inserted into a jacket of cast iron, and held there by a screw, which, passing through the jacket at the breech, entered 1·3 inches into the steel. The casing extended about half the length of the gun, and griped the barrel only at its two extremities, leaving a free space of ·07 inches to allow the steel tube to expand. The jacket weighed 261 lbs., and the gun complete 490 lbs. The experiments consisted, first, in firing a number of rounds, principally with a view to ascertain if the bore suffered damage by indentation from the action of the balls; 220 rounds in all were fired, and very careful ex-

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aminations made at intervals: a scarcely perceptible deterioration appears to have taken place. After this, it was determined to burst the gun. The firing commenced with 1¼ lbs. of powder, 2 shot, and 1 hay wad; at each succeeding round, an additional shot was used until the charge amounted to 1¼ lbs. powder, 15 shot, and 1 hay wad, completely filling the gun. After this round the gun was carefully examined; no injury appeared to have been done to the bore, except some sharp indentations, caused by fragments of the shot which were broken in the gun by contact against each other. The charge of powder was then increased, and at the same time the number of shot diminished. Finally, at the 21st round, the gun burst, with a charge of 10 lbs. powder, 5 shot, and 1 hay wad.

A 12-Pounder Gun was subsequently made on the same principle, and subjected to some severe trials in Prussia, and afterwards sent to Woolwich for further experiment.

About the same time, (early in 1855,) the material for a larger piece of ordnance was received at Woolwich; this consisted of a cylinder of cast steel, cast solid, and then forged. In this state it was sent to Messrs. Walker's, of Gospel Oak Works, to be bored, and fitted with a cast iron jacket; the gun complete was returned from Messrs. Walker's in October. The following are some particulars respecting dimensions, &c.:—

The separate weights of the steel core and cast iron jacket are not stated, but appear to be nearly equal; the total weight was 165 cwt., or 8 tons 5 cwt.; calibre of bore 8·05 inches; thickness of steel, 5 inches at the bottom of the chamber, 4·1 inches in front of chamber, diminishing to 2·5 inches at the chase; the diameter of the base ring was 37·5 inches; the jacket was 10 inches thick at the breech, and 8·5 inches in front of the trunnions near the front extremity. This jacket was secured to the steel barrel by a screw entering the steel to a depth of 6 inches, leaving still 7 inches between the end of the screw and the bottom of the chamber: the length of the gun was 10 feet, and the preponderance 27 cwt.; a very large amount, although in order to diminish it, the trunnions had been placed more to the rear than usual.

The jacket was so fitted as not to come in contact with the barrel, except in two parts, viz.:—at the two extremities, the breech and about the middle of the barrel; at the latter extremity (the mouth of the jacket) a wrought iron wedge ring encircled the barrel, and was fixed to the jacket by screws. On the 19th November, the gun was fired for proof in the Royal Arsenal. The shot supplied with the gun was cast iron, of a cylindro-conical form, and a flat base; the base had a ringed channel cut in it, wedged shaped, and about 2 inches deep, leaving about one-tenth of an inch of metal between it and the outer surface. The purpose intended by this cavity was the expansion of the flange, thus left, against every part of the bore, and

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so prevent windage. The weight of the projectile was 259 lbs.: the charge of powder was 25 lbs. On the first discharge the gun burst into 10 large pieces and a multitude of small fragments; the muzzle portion, about 5 feet long, was carried forward with the projectile to the foot of the Butt; another large fragment was thrown to the rear. The projectile itself, after entering the Butt, glanced upwards, and coming through at the other side fell into a shed beyond. The fracture of the steel exhibited a remarkably fibrous appearance; part of the jacket was much honey-combed.

After the extraordinary strength shown in the former trials of guns of this material and construction, it is difficult to account for the failure just described. It can scarcely be supposed that the small thickness of metal, left as a flange on the base of the projectile, would be sufficient to cause it to be jammed in the bore; although, undoubtedly, the flange would form a wedge between the shot and the bore, as, in fact, it was intended to do for the purpose of diminishing the windage. Captain Crease, who was present, seemed to be of opinion that the jacket did not permit the steel barrel as much freedom for expansion as it was intended to have.

Armstrong's Rifled Field Gun.

Mr. Armstrong was authorized by the Duke of Newcastle to construct one or more guns, not exceeding six in number, on the plan he had suggested in an interview with his Grace, and to make the necessary experiments in connection with the subject, at the Government expense. Mr. Armstrong, acting upon this authority, has confined himself, up to the present time, in the production of a single gun; to make that one gun a test, not only of the principle he had recommended, but also of the feasibility of loading a Field piece at the breech; and likewise of applying certain mechanical arrangements to counteract recoil, and facilitate the laying and pointing.

Careful consideration was first given to the tensile strength of various materials suitable for the construction of a gun, and some experiments were made on the strength of cylinders of wrought iron, forged in the requisite form, and afterwards bored; the result of these experiments shewed great uncertainty in the strength of the material, rendering it impossible to define the thickness necessary to resist a given charge of powder. Mr. Armstrong then decided upon, and ultimately completed a gun of which the following is a description:—A core, or internal lining for the gun, was formed of cast steel, to which the requisite strength was given by encircling it with twisted cylinders of wrought iron, made in a similar manner to gun barrels, and tightly contracted upon the steel core by the usual process of cooling after previous expansion by heat; the parts are then in that state of

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initial tension which is necessary to bring their entire strength into operation. Considerable difficulties were encountered in carrying this plan into practice.

The arrangement for loading at the breech, consists of a powerful screw, having a hole through the centre in the prolongation of the bore, through which hole the bullet and charge are delivered into the gun. A "breech piece," with a mitred face fitting a similar face at the end of the bore, is dropped into a recess, and by the action of the screw pressed tightly into its seat, so as effectually to close the bore. The fitting surfaces which close the bore were at first made of unhardened steel, this failed; hardened steel was next used, but this yielded to the action of the powder more rapidly than before: copper was then tried, and no further difficulty was experienced. The breech piece contains the vent. The bore of the gun which was made, is $1\frac{3}{4}$ inches in diameter, and contains 8 spiral grooves, having an inclination of one turn in 12 feet; these grooves terminate at a distance of 14 inches from the breech, and the bore then gradually expands in a length of 3 inches, from $1\frac{3}{4}$ inches to $1\frac{7}{8}$ inches in diameter. The bullet, in the process of loading, passes freely through the widened space; but its diameter being a little in excess of the bore, it lodges in the tapered contraction at the commencement of the grooves.

The weight of the gun by itself is about 5 cwt.; including the carriage, the weight is about 15 cwt., which is nearly indentical with that of the Light 6-Pounder Brass Gun and Carriage of the Service. The weight of the projectile, (composed of lead, hardened with antimony and tin,) is 3 lbs. A long course of experiments was made to determine upon the best form of bullet; numerous forms were tried, and Mr. Armstrong was of opinion that experiments required to be still prolonged, in order to arrive at the greatest attainable perfection. The form last used was a cylinder pointed in front, with a conical end behind. The charge was 14 ozs. of fine blasting powder.

There is an ingenious arrangement by which the recoil is absorbed; and another by which the pointing and elevating is expeditiously and correctly performed.

Mr. Armstrong considers that Rifled Guns of this construction will be especially valuable as guns of position where a long range is required, and proposes them as *adjuncts to*, and not *substitutes for*, the present description of Field Ordnance. The objects he believes to have attained are, strength, durability, long range, and accuracy.

Respecting the construction of Heavy Ordnance by the process of twisting wrought iron bars into cylinders, and combining them in the manner described, he believes no difficulty would be experienced, if proper apparatus were provided for the purpose; but he does not recommend the breech loading principle to be applied in such cases,

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because, in Heavy Ordnance, the moveable parts would be too cumbrous to be conveniently handled.

The gun described above, was brought to Woolwich to be inspected, and was then sent to Shoeburyness for experiment. Mr. Armstrong stated that 800 rounds had already been fired from it.

At Shoeburyness, 100 rounds were fired at elevations varying from ¼° to 7°. A very long range was obtained, though it was not always uniform; the direction was extremely accurate. The shot did not proceed point foremost after the first graze. All the shots that were recovered, shewed marks of their having completely taken the rifle grooves. A considerable escape of gas took place at the breech; the gun was loaded with great facility, and pointed quickly and accurately: the recoil was checked, but not entirely absorbed by the action of the slide on which the gun is mounted.

After the completion of these experiments, Mr. Armstrong, believing the gun to be stronger than necessary, suggested its being returned to him to have it rebored for a heavier projectile, and also to make some alteration in the rifling, by which he expected to obtain increased accuracy of fire. The gun was accordingly sent back to Newcastle.

Holroyd's Malleable Metal Gun.

Mr. Morgan, in a letter to the Duke of Newcastle, dated 6th January, 1855, submitted that "Malleable Iron Guns ought to be substituted for Brass Ordnance." He proposed that guns for Field Batteries should weigh about 20 or 21 cwt., to throw an 18 lb. spherical shot; and for the Horse Artillery 14½ cwt., to throw a 12 lb. spherical shot; or that the calibres should be respectively less, so as to permit of the use of guns of the same weight for elongated projectiles.

The metal, Mr. Holroyd stated, is not "ordinary wrought iron," but a "peculiar gun metal wrought." Mr. Morgan admitted that the cost of ordnance of this kind would equal that of brass, but he was of opinion, that the greater endurance of the malleable iron would entitle the latter to the preference.

As a comparative trial of a gun of this material against brass, Mr. Holroyd sent to Woolwich a gun, which had originally been made of the same weight as the 9-Pounder Brass Gun of the Service, viz., 13½ cwt. Hearing, however, that the French and other Powers used a gun for Field Service throwing a heavier projectile, he had it bored to the calibre of a 12-Pounder; its weight in this state was 12 cwt. 3 qrs. 14 lbs. For the purpose of comparison, a 9-Pounder Brass Gun of the Service was bored up to a 12-Pounder, to make it exactly the same weight and calibre as Holroyd's. This gun, together with Mr. Holroyd's, were sent to Shoeburyness for compara-

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tive trial. The trial was as follows, both guns being placed under precisely similar circumstances:—

No of Rounds.	*Powder.*	*No. of Shot.*	*Wads.*
10	5 lbs.	2	1
10	5 „	3	1
10	6 „	2	1
31	6 „	3	1

At this time the Brass Gun became quite unserviceable.

During the progress of the experiments, frequent examinations were made of the state of both guns, the results were reported as follows:—

Service Brass Gun;—It was observed that after the first 5 rounds a slight indentation in rear of the dolphins had taken place; after 10 rounds a 2nd indentation was perceived; after 25 rounds a 3rd indentation, and the copper bouching slightly started inside. The indentations became deeper and more numerous as the firing continued. At the 61st round some small cracks were observable outside the muzzle, the gun was much bulged at the chase, and, as above stated, was then considered unserviceable.

Holroyd's Gun;—At the 61st round, when the Brass Gun was rendered unserviceable, no deterioration, except enlargement of the vent, was perceptible in Holroyd's Gun; the firing was then continued with it alone. 54 rounds, 6 lbs. charge, 3 shot, and 1 wad were fired; at this time, (115 rounds in all) a portion of the bouching ·8 inch deep was blown off; vent much enlarged; no other defect visable.

From the enlargement of the vent, it was thought necessary to send the gun to Woolwich to be re-bouched.

The gun, re-bouched, was returned to Shoeburyness, and the experiment re-commenced on the 14th January, 1856. Between that date and the 28th February, 141 rounds were fired, 6 lbs. charge, 3 shot, and 1 wad. The bore was examined at the conclusion of every 5th round, it appears to have sustained no injury, and no change is observable but a slight enlargement of the vent.

On 14th January, the dimensions of the vent were:—At top ·22; at bottom ·22 inch.

On 28th February.—At top ·25; at bottom ·50 inch.

The gun is still under trial.

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Remarks on the duties of the Artillery at a Siege.

By Colonel E. N. Wilford, R.A.

The recent Siege of Sebastopol has drawn the attention of Officers to the operations of Sieges in general, in which the Corps of Artillery has to take so large a share.

It is well known that it was to an accumulated and increasing fire of heavy Artillery that the Allies looked chiefly for success in that memorable operation, and Prince Gortschakoff acknowledged in his public report to his own government, that the fire of the Allied Artillery had become so destructive, that he would have found it necessary to evacuate the place had the capture of the Malakoff not occurred.

Having been lately engaged in so gigantic an operation, the success of which so much depended upon the vigorous and continued action of the Artillery, the time seems fitting for considering whether the existing practice of the British Service be in all respects the best calculated to ensure the utmost effects producible, by a Corps of Artillery possessing so excellent a *personnel* and *matériel* as does the British.

It is much to be regretted, that there exist in the British Service no authorized Regulations pointing out the general duties of the Artillery at a Siege, and their relative duties and relations with the Royal Engineers and other branches of the Army. We are left to seek for analogies in the French and other Continental Armies, and it is believed they all follow the same, or nearly the same system.

As regards France, the respective functions of the Commanders of the Artillery and Engineers are clearly laid down by Royal and Imperial Ordinance.

For instance, translating, as literally as may be, from the Ordinance of December 9th, 1840, to be found page 657, *Aide Mémoire à l'Usage des Officiers d'Artillerie*, 1844," it is stated under the head of "Sieges":—

"The Commander of the Engineers draws up, according to the instructions of the General Commanding at the Siege, the general project of the Siege.

"In case he receives it already drawn up, he develops, if there be occasion, its dispositions.

"This Project is first examined by the Commander of the Engineers, and the Commander of the Artillery conjointly.

"These two Officers submit their common opinion, or their different opinions to the General in command, who decides, determines the project after having modified it if he sees fit, and gives the necessary orders for carrying it into effect. The same course is fol-

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lowed as regards the changes which the events of the siege may render it necessary to make in the plan as at first approved.

"The same rules apply to the daily service of the Trenches, and to the means of executing the general project.

"These means are proposed to the General on duty for the day in the Trenches by the Commander of the Engineers in the Trenches, after having been discussed by him with the Commander of the Artillery in the Trenches.

"This General pronounces upon their common or respective opinions, but if the delay is not disadvantageous, he refers the matter to the General Commanding."

It must be understood that the Commanders of the Artillery and of the Engineers in the Trenches cannot propose to the General of the day any measure or course of proceeding not in strict accordance with the instructions they have previously received from their own immediate Chiefs, the Commanders of the Artillery and of the Engineers of the whole army, acting under the authority of the Commander-in-Chief.

Nor can the General of the day of his own authority give any orders to the Commanders of the Artillery and Engineers in the Trenches contrary to those they have received from the Commanders-in-Chief of the two Arms at the Siege.

The interposition of the authority of the General of the day is restricted to decisions in cases of emergency requiring immediate action, such as a successful sortie by the garrison, mines being sprung, &c.

Here we see indicated a perfectly clear course, which, indeed, in principle, agrees perfectly with the General Order of the Master-General and Board of January 10th, 1853, $\frac{M}{2}$, laying down the relative duties of the Commanding Officers of Artillery and Commanding Royal Engineers, with regard to New Works, and Batteries, and their Armaments, and also as respects any proposed change in existing works.

Although in every case the weight which a General Commanding at a Siege may be disposed to attach to the individual opinion of either of the Commanding Officers of the two Scientific Arms of the Service, must depend upon such General Officer's opinion of the talent and military experience of those Officers in particular, it seems essential to the good of the service that, as a rule, each of them should be called upon to make his views known, and have, in some sort, a claim to have his opinion considered by the General Commanding

For, it is obvious that, presuming equal competence to their respective Duties, there will be many points on which the Commanding Officer of Artillery must be a better judge than the Commanding Engineer, as there must be many others on which the latter Officer's opinion should naturally prevail.

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In the absence of any authorized Regulation on the subject, it would seem judicious, so far as it may rest with individual Officers to seek to follow the French system, for that nation which has produced Vanban, and so many other eminent Engineers, has had more experience in the War of Sieges than any other, and may well be believed to have adopted the best general system for conducting such important operations.

It is plain that the good of the service will be promoted by the Artillery and Engineers working cordially together, and the best means of securing such harmony and good understanding, will be to act upon a good and well understood system.

While it may be hoped that some such Regulation as the French on the subject of the Projects or Plans of Sieges, and the various measures necessary to be taken in the progress of the attacks, may be established and promulgated by authority for the guidance of the British Service, it may be well to consider whether the practice of our service, as to the actual execution of some of the necessary works, might not be changed with advantage.

In the French, Prussian, Austrian, and Spanish Services, and, it is believed, in that of Russia and the minor States of the Continent, it is the established practice for the Artillery to establish and construct all the Batteries at a Siege, with their Magazines, Platforms, and Communications, providing also all needful Traverses and Mantlets for the protection of the Gunners.

Indeed, the Ordinance of May 3rd, 1832, (see page 656, Aide Mémoire, 1844,) provides (article 11,) as follows:—

"The Corps of Artillery is charged with—1. The *establishment* and *construction* of all the Batteries, and with the service of the Ordnance in general."

To enable them to perform these duties without recurring to the assistance of any other branch of their service, every Company or Battery of French Artillery has a certain number of *Ouvriers en fer et en bois*, as they are termed, or tradesmen for the construction and repair of Artillery *Matérial*. These workmen are in addition to Farriers, Shoeing-Smith, Collar-Makers, in proportion to the equipment of horses.

There are besides whole Companies of Artillery Workmen, who form a part of every Artillery Force, and are employed in the various operations of the Parks of Artillery.

As to Batteries, supposing a regular Siege, the Engineers having directed the opening of the Trenches, and the construction of the first Parallel, according to the approved general project for the Siege, the Artillery construct the first Batteries and their Communications in similar conformity to the Project, and so on throughout. In the more advanced stages of the attacks, such as the crowning of the Covert Way, the Engineers gaining the ground by Sap, and then when needful, handing over the Trench to the Artillery to widen and convert it into a Battery with all its appurtenances. For

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the purpose of these constructions the Artillery make daily demands for Working Parties of Infantry in like manner as do the Engineers. In the French Service a superior Officer of the Staff, or of the Infantry, and styled *Major de Tranchée*, is especially appointed by the General Commanding, for regulating the Infantry duties and details of the Working Parties.

In the Defence of a Fortress, all permanent works having, as with us, been constructed by the Engineers, the French Artillery open Embrasures where required, lay temporary Platforms, construct Expense Magazines and Blindages where wanted for the Batteries; and, in short, perform all the corresponding duties they are charged with in the attacks.

It will be seen that by the French, or rather Continental System, the Artillery does not throw upon another Arm, the Engineers, the burden of works they are so well able to execute for themselves, it being understood that their strength of Artillery is estimated on the basis of their performance of these duties.

There is a very strong presumption that our opposite practice must be unwise, and now that the system of sending forth our Armies insufficiently provided, as to force of Artillery, is happily discarded, there seems no reason why the British Artillery should not, ere long, assume the duty of constructing, as well as arming and fighting their own Batteries.

Some striking advantages would follow such a change.

The Engineers would be relieved from a heavy duty, and have more time and means to bestow on their general duties of pushing on the approaches, making lodgments and cover for firing parties, and for every form of subterranean warfare, &c.

Above all, the Batteries would be constructed by those who are best aware of the proper use and effects of the Ordnance to be employed. The same parties who were to arm the Battery and serve the Guns would have to construct and keep it in repair, and they could have the responsibility as well as the strongest interest in its being of as perfect a construction as possible. The Artillery Officers would themselves be able to ensure that the Parapets were of the proper thickness, and of the best material at hand, that the Embrasures were perfectly directed, the Magazines, as well those for Cartridges as for Shells, sufficiently secure and spacious, the requisite Traverses and Mantlets provided, the Drainage and requisite Communications for Arming the Batteries properly established; and lastly, all occasion or even possibility of complaint on the part of the Artillery, that the Batteries or details of them had not been constructed in the best manner by the Engineers, would be removed.

If the British Artillery were charged with the same duties at a Siege as Foreign Artilleries, the Officers would be led to study more attentively than they sometimes do the Science of the Attack and Defence of Fortresses, and this study would lead them to a better understanding of the use and application of Artillery in Siege opera-

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tions, as well as induce them to make increased efforts for the improvement of Siege and Garrison Ordnance and Equipments.

Even with the present system, it is to be desired that Officers of Artillery should study the construction of Batteries in all their details; for a thorough understanding of this subject will place them in a position to give a more valuable opinion upon Projects of Attack, or Defence of Fortresses and Fortified Posts, they may be called upon to discuss, and will also enable them to indicate to Engineer Officers, with whom they may have to co-operate, many points of construction of much consequence to the efficient serving of the Guns of a Battery.

Although it is to be regretted that the Officers and Men of the Artillery do not receive sufficient practical instruction in the construction of Batteries, very much information may be acquired from Books, such as the before cited *Aide Mémoire* of the French, the *Aide Mémoire* of the Military Sciences, edited by Major-General Lewis and other Officers of the Royal Engineers, and Lieut.-General Sir Charles Pasley's *Practical Operations of a Siege.*

In order to instruct their Officers and Men, the French and German Artilleries construct and arm a certain number of Siege Batteries, which are completed in every detail the same as required on service. This is done annually in their Polygons or Plans for Exercise and Gun Practice, and from their Batteries they carry on Target and other Practice.

Trusting that some of the distinguished Officers of the Corps, who have served at Sieges in the Peninsula, or at Sebastopol, may give their attention to the subject, these remarks are hazarded in the belief, that the questions they involve are of much importance to the good of the Service.

The writer would not have ventured to put them forth was he not aware, from personal communication with that most distinguished Officer the late Sir Alexander Dickson, that his opinion was:—every Officer of Artillery should be competent to the construction of Batteries, and it is equally well known to him that the late Colonel Colquhoun maintained that the Artillery should construct their own Batteries at a Siege, and not be dependent upon another Arm of the Service for the performance of what he regarded as part of their own proper duties.

The Order of January 10th, 1853, is appended for the sake of easy reference.

No. 1610. GENERAL ORDER.

Office of Ordnance, 10th January, 1853, $\frac{M}{2}$.

With reference to the Master-General's and Board's Order, dated 9th September, 1833, directing, in all cases of proposals for the ar-

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rangement of New Works, or of alteration of that of other Works, a joint report to be forwarded to the Master-General and Board by the Commanding Officer of Artillery and Commanding Royal Engineer at the Station to which the Works belong.

The Master-General and Board revise and extend such order as follows:—

On all occasions when new Batteries or their Armaments may be called for, or when alterations in Fortresses or other existing Works may be proposed, the Commanding Officer of Artillery, and the Commanding Royal Engineer, are to make a joint report to the Director-General of Artillery, and Inspector-General of Fortifications, respectively, as heads of their Departments, with a view to the two latter Officers forwarding the same to the Master-General, with their remarks.

In carrying out this duty, the two Commanding Officers are to confer together, and on a plan proposed by the Commanding Royal Engineer, shew the position of the proposed Battery or Batteries, and describe the service for which the Works are intended; detailing the number of Guns and their nature, how proposed to be mounted, and the character of the Platforms; also, the Shot Furnaces, Racers, Pivots, and all other articles required for the Armament of the several Works.

Should there be no difference of opinion, the plan in duplicate is to be signed by both Officers, and one of the copies transmitted by the Commanding Officer of Artillery to the Director-General of Artillery, and the other by the Commanding Royal Engineer to the Inspector-General of Fortifications.

Should the Commanding Officers differ on any points, the views and opinions of each are to be stated on the face of the plan, or in any other manner agreed upon by them; that their separate opinions may together be placed before the heads of their respective Departments.

In all cases requiring such joint reports, the Commanding Officers will receive their instructions from the heads of their respective Departments—but as occasions may arise when the Director-General of Artillery, or the Inspector-General of Fortifications may require information on Batteries and Armaments where the Commanding Officers of Artillery and Engineers at Foreign Stations may think alterations or proposals desirable—in order to avoid loss of time by reference to Head-quarters for authority, in cases when the Commanding Officer of either Corps has occasion to make new propositions, or afford information regarding Batteries, Armaments, &c., on which a joint opinion should be given, the other, at his request, will join in a report, which each will then make to their respective Head-quarters.

By order of the Master-General and Board,

G. BUTLER, Secretary.

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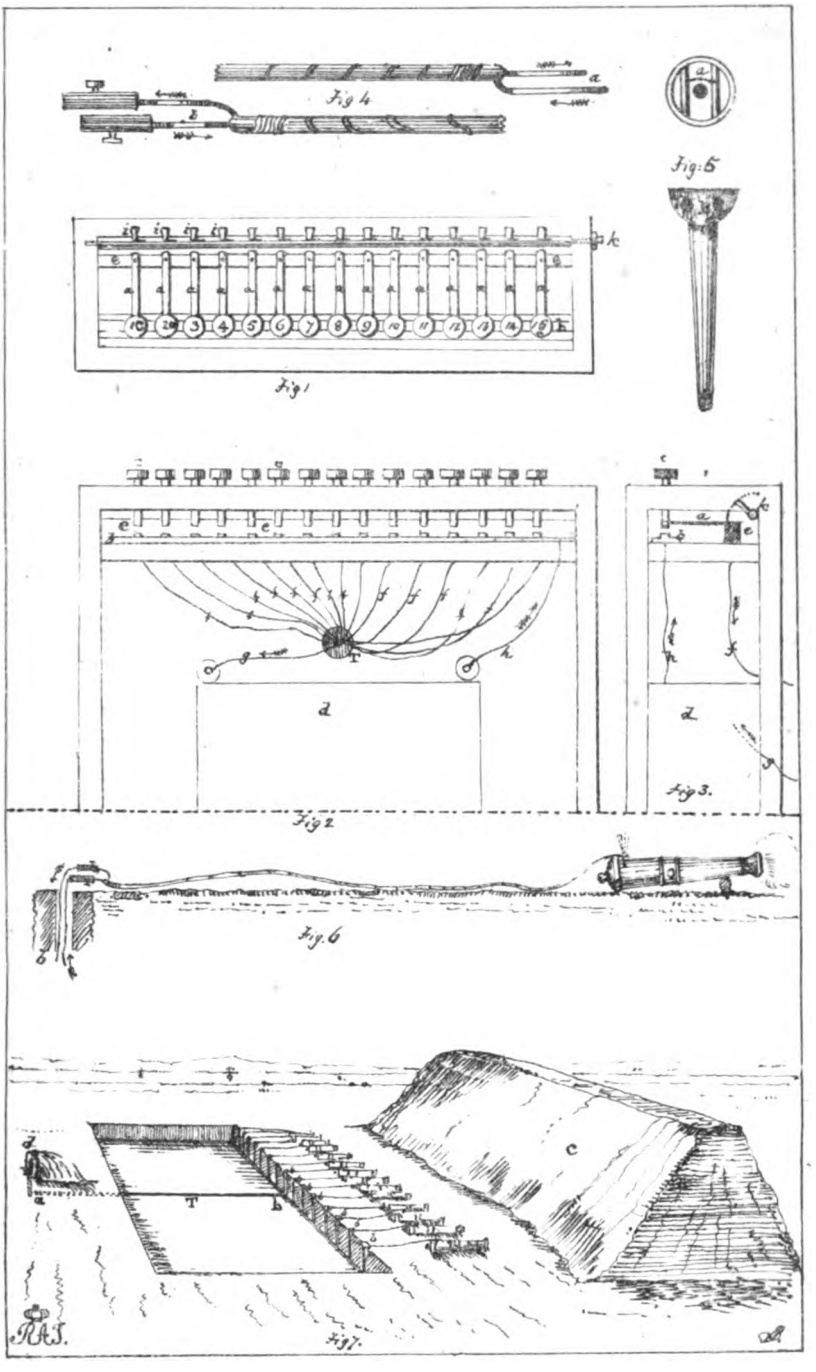

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Detail of the Plan of Firing Guns by Galvanic Agency, and practised in the Proof Department, Royal Arsenal.

Arranged by P. M'KINLAY, Proof-Master, Royal Gun Factories.

Before proceeding to explain the new method of firing guns under proof by Galvanism, it will be as well, perhaps, to state the method which has thus been superseded.

The guns, &c., for proof, were placed on the ground in front of the Butt, their muzzles being slightly elevated and pointing towards it, they were loaded with charges according to their nature, and primed with a tube, over which a piece of portfire, intended to burn about three minutes, was fastened with clay. All being ready the portfires were lighted, and the proof party then retired to a safe distance.

It will readily appear that such a method of firing guns must be very irregular, and even hazardous, for, should a gun burst, (and this is a contingency which sometimes occurs,) the consequences might be fearful; indeed, a case of this kind occurred a few years ago in the following manner; a gun burst, and one of the large fragments struck an adjoining gun, slewing it completely round, so that the muzzle pointed towards the Dockyard, and the portfires having all been lighted, the charge exploded, and a 56-Pounder Shot was lodged in one of the buildings of Her Majesty's Dockyard, most providentially doing but little damage; again, during the past winter, while testing some 13-Inch Mortars, one of them burst, and, as in the case of the 56-Pounder, slewed another round, the charge of which, however, had been fortunately fired before the Mortar was struck.

This latter occurrence was reported to Lieut.-Col. Eardley-Wilmot, the Superintendent of Royal Gun Factories, who, after visiting the proof ground, ordered that until a better plan could be devised, only one gun should be fired at a time, and also directed me to make some arrangement by which Galvanism could be advantageously substituted for the portfire process.

The arrangements about to be described have been tested daily for the last four months, and have established the superiority of the Galvanic process over the old method, and much credit is due to the workmen of the department for the intelligent manner in which they have assisted in carrying into practice the principles of a science so far removed from their ordinary avocations.

DESCRIPTION.

Stationary Wires, &c.

Fig. 7. About 70 yards from the centre of the Butt *c*, a splinter-proof *d* is built, in which the Galvanic Battery and Commutator are placed, in connexion with these are fifteen wires (one for each gun) covered with gutta percha, and a single plain wire for the return current, these are led under ground through a metal pipe *a b* to about 50 feet from the Butt, where they diverge and run parallel to it; at

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this point branch wires are soldered to the single wire, the ends of both wires are brought up in succession to the surface of the proof ground through traps *b*, placed six yards apart.

The underground arrangement is shewn at T in the diagram, which is *represented* here in the form of a trench in order to display this; but no such trench really exists.

Moveable Wires.

Fig. 4, *a* and *b*. Moveable wires are used for conveying the current from those in the traps to the guns, each set is composed of a wire covered with gutta percha with a plain one twisted round it; one end *a* is forked, the other end *b* has binding screws soldered to each wire for the purpose of attaching them to those in the trap, thus forming a continuous line from the splinter-proof to the guns. fig. 6.

Galvanic Tube.

Fig. 5, *a* and *b*. The galvanic tube differs from the common quill tube in having a wooden cup *b*, ·7 inch diameter, through which two small copper tubes are fixed horizontally, and joined together by a fine wire *a*, (Iron or Platinum) length ·2 inch, diameter ·02 inch; the cup is primed with common gunpowder, a paper cover is pasted over, and varnished in order to keep the priming dry.

The tube is attached to the moveable wires by pressing the forked end into the small copper tubes of the cup. It is necessary that they should be perfectly clean, and fit tightly to insure a metallic connexion; the tube, in this state, is then placed in the vent of the gun ready for firing. fig. 6.

Commutator.

Figs. 1, 2, and 3, the references being the same for each. By means of this apparatus the guns can be fired in regular succession or otherwise, and if necessary the whole can be fired together—fig. 3, *c*, a metal key, tipped with platinum, supported by a brass spring *a*, and firmly screwed into the wooden bar *e*.

b, a bar of metal, on which small discs of platinum are fixed, so that the keys when depressed will touch them.

d, a Galvanic Battery of 12 pairs, excited with dilute sulphuric acid, one pole of which is attached to the bar *b* by the wire *h*, the other pole to the wire *g*, which conveys the return current.

f f, wires leading to the guns, and attached to the springs which support the keys.

k, a revolving bar with metal tongues *i i* attached to it, these when brought into contact with the springs *a a*, by turning the handle *k*, connect the whole together; by this arrangement the guns could be discharged simultaneously by depressing any of the keys *c c*.

It will be obvious to those acquainted with Galvanism, that so long as the key *c* is kept from the metal bar *b*, no current can pass along the wires, but if the key be depressed so as to touch that bar, the current will flow and fuse the small wire in the cup of the tube, thus effecting the instantaneous and safe discharge of the gun.

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ANNUAL REPORT

AND

PROCEEDINGS OF A GENERAL MEETING,

HELD ON FRIDAY, 20th JUNE, 1856,

COLONEL E. N. WILFORD, ROYAL ARTILLERY,

IN THE CHAIR.

The Committee of the Royal Artillery Institution beg to submit the following Report:—

The Committee did not consider it advisable to call the usual Annual General Meeting last year, because, owing to the war, few Officers were in the Garrison. The thoughts of all were occupied with events of the deepest interest to Military men of every grade, and under these circumstances little time could be spared for relaxation from duty.

The Committee congratulate the Members on the satisfactory state of the funds of the Institution. The Members at the present date number 714, viz., 646 Officers on the effective list, and 68 retired from the regiment.

The following is an Abstract of the Accounts of the Institution showing a balance Creditor, on the 31st March, of £212. 11*s*. 7½*d*.

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GENERAL ABSTRACT OF THE INCOME AND EXPENDITURE OF THE ROYAL ARTILLERY INSTITUTION, FROM 1st APRIL, 1854 TO 31st MARCH, 1855.

INCOME.

			£	s.	d.
By Balance, Cr.			290	3	8
„ Subscriptions			493	3	0
„ Dividends on £500 Consols			14	2	6
„ Printing			87	11	6½
„ Publication—Sale of "Hand-Books"			14	10	0
„ Classes	Drawing	Instruction	17	18	11
		Materials	8	10	11
	Chemistry	Instruction	20	2	6
		Materials	14	0	5
	Mathematics	Instruction	9	7	6
„ Sale of Photographic Materials			1	12	3
„ Sale of Turning Materials			0	7	8
„ Overcharges			2	5	0
Donations towards refreshment at the opening of the Institution			1	15	0
			£925	10	10½

EXPENDITURE.

		£	s.	d.
Chemistry	Instruction	55	15	6
	Materials	0	1	6
Drawing	Instruction	67	14	6
	Materials	7	10	0
Lectures		16	16	0
Mathematics		12	15	0
Publication	Dalziel—Wood Cuts for "Hand-Book"	81	12	6
	Bradbury and Evans—Printing	85	0	0
	Chapman & Co.—Biddulph's "Sketches"	40	16	8
	Expenses connected with the above items	3	1	4
Printing	Wages	26	9	4
	Materials	42	19	1
	Paper	40	4	1
Apparatus		20	2	0
Furniture		164	17	5½
Instruments		4	2	6
Insurance		5	1	3
Library		35	18	3½
Museum		21	1	5
Observatory		5	0	3
Photography		26	13	0
Postage and Parcels		8	8	10
Repairs		1	12	5
Stationery		2	2	8
Transcribers		24	16	2
Turning Room		3	4	6
Wages		56	11	0
Incidentals		5	8	5½
Unpaid Subscriptions		1	15	0
Balance, Cr.		58	0	2
		£925	10	10½

C. W. YOUNGHUSBAND, Captain, R. A.,
Secretary and Treasurer.

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GENERAL ABSTRACT OF THE INCOME AND EXPENDITURE OF THE ROYAL ARTILLERY INSTITUTION,

FROM 1st APRIL, 1855 TO 31st MARCH, 1856.

INCOME.

	£	s.	d.
By Balance, Cr.	58	0	2
„ Subscriptions	566	15	0
„ Dividends on £500 Consols	14	0	0
„ Printing—Allowance for Press	50	0	0
„ Printing—Printing for Adjutant-General's Office	35	0	0
„ Printing—General Printing	48	12	7
„ Publication—Sale of "Hand-Books"	186	0	9
„ Classes ... Drawing ... Instruction	1	16	8
„ Classes ... Drawing ... Materials	2	4	2
„ Classes ... Mathematics—Instruction	4	17	6
„ Sale of Photographic Materials	6	11	2
„ Sale of Paper	0	3	7
„ Overcharge—Wood for Museum	0	10	6
	£974	12	1

EXPENDITURE.

	£	s.	d.
Chemistry—Materials	41	12	6
Drawing—Instruction	13	13	0
Lectures	3	3	0
Mathematics	12	15	0
Publication—Dalziel—Wood Cuts for "Proceedings"	5	12	9
Publication—Bradbury and Evans—Printing	108	6	3
Publication—Walton&Co—LitbographingBiddulph's"Sketches"	64	16	0
Publication—Mr. Forrester,—700 copies of Biddulph's third "Sketch"	43	15	0
Publication—Expenses connected with the above items	0	15	6
Printing—Wages	54	5	7
Printing—Materials	131	15	2
Printing—Paper	52	17	11
Furniture	66	16	5
Instruments	9	11	3
Library	8	5	6
Museum	38	7	11½
Observatory	3	6	0
Photography	0	8	8
Postage and Parcels	6	10	8
Repairs	0	6	4
Stationery	23	4	3
Transcribers	0	3	0
Turning Room	9	12	0
Wages	61	0	6
Incidentals	10	0	3
Balance, Cr.	212	11	7½
	£974	12	1

C. W. YOUNGHUSBAND, Captain, R. A.,
Secretary and Treasurer.

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Classes.—Notwithstanding the limited number of Officers at any one time in the Garrison, during the war, and the heavy duty imposed upon them, the Classes in French and German have been maintained.

The Drawing Class, for a short time in abeyance, was re-established under Mr. Campion in October last, and continues to be regularly attended.

A Class for Surveying and Field Sketching was formed in November last, to which Captain Palmer, Royal Artillery, Instructor in these branches to the Practical Class of Cadets, volunteered his assistance. This circumstance having been brought to the notice of the Secretary of State for War, he was pleased to authorize a grant of money to remunerate Captain Palmer for the services he had proposed to give; the Committee have the satisfaction of announcing that arrangements have been made to enable Captain Palmer to attend at the Institution, two days in each week, for the purpose of instructing any Officer desirous of acquiring a knowledge of Surveying and Military Field Sketching. Many Officers have availed themselves of this opportunity.

Printing and Publication.—Considerable additions have been made to the Printing Department consequent upon the increased demands for printed work of various kinds.

In accordance with an estimate which was made of the amount of printing required for General Orders and Circulars from the Adjutant-General's Office, the Committee proposed on the part of the Institution to print all General Orders, &c., for an allowance of £35 per annum; this sum being calculated as sufficient to pay the wages of a printer whom the Adjutant-General would allow to be employed, and a per centage on stock for wear and tear. In the first instance, £50 additional was asked for, towards the cost of a new printing press: the whole arrangement was agreed to by the Secretary at War, and the annual allowance commenced 1st January, 1855.

The two Lists of the Regiment issued monthly—one shewing the detail of Commands and Companies, the first number of which was issued on the 31st May, 1855—the second, "Officers in the order of Regimental Rank," first issued on the 1st January, 1856—the Committee hope have been found useful.

The whole of the first impression of the "Hand-Book for Field Service" was nearly exhausted, when a communication was received from the Comptroller of H.M. Stationary Office, that the Government were desirous of procuring 1,250 copies of this work. A second edition was therefore immediately put in preparation.

If a reprint only of the first edition had been required, the preparation would have proceeded with little delay or trouble, but some al-

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terations have been deemed advisable, and various corrections found necessary, and the Committee have thought it better to risk a little delay for the sake of eventually producing a work which it is hoped will be found correct and useful by all those into whose hands the book may be placed.

The printing of the work, the first edition of which was undertaken by Messrs. Bradbury and Evans, the Committee decided upon attempting at the Institution, both for the sake of convenience and economy, although the stock of type required to be much enlarged; 64 pages have been printed, copies of which are on the table, and the remainder of the work is proceeding satisfactorily.

The sum agreed to be paid by the Government for the number of copies ordered, will, it is believed, be a remunerating price, but the Committee in agreeing to the rate proposed by the Comptroller of H. M. Stationery Office, felt more anxious that a work issued as a portion of the Proceedings of the Institution should be creditable as a Publication of the Institution rather than a profitable speculation.

Within the past year copies of five Sketches, made by Major Biddulph, of the ground and works before Sebastopol have been issued to every Member. The Committee believed that these sketches would be found extremely interesting at a period the most important operations of modern times were in progress.

Museum and Library.—The Committee have the pleasure of announcing several valuable donations to the Library and Museum, of which a list in detail is appended to the Report. The volumes on Artillery, and subjects connected therewith, presented by his Excellency the Minister at War to the King of Sardinia,—various manuscript plans and papers on professional subjects of the late Sir John May, presented by Lady May,—about 100 specimens of birds, killed in New Brunswick, stuffed by Lieut. Blakiston, and presented by him;—a case of specimens of woods from Ceylon, presented by Lieut. Sievwright,—deserve especial notice.

The arrangements made with Mr. Whitely relative to stuffing and arranging the specimens of Natural History presented to the Museum still exists, and a considerable number of bird skins have been stuffed and set up within the past year.

Committee.—The Master-General of the Ordnance has hitherto been PATRON and PRESIDENT of the Institution.

In consequence of certain changes which have recently been made, the Committee recommend that a respectful letter be addressed to the Field-Marshal Commander-in-Chief, requesting him to permit his name to be enrolled as PATRON and PRESIDENT of the Institution.

The Committee also recommend that Rule IV. be further altered by substituting *Adjutant-General* for Deputy-Adjutant-General; *Assistants*-Adjutant-General for Assistant-Adjutant-General; and

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Secretary of the Ordnance Select Committee for Assistant-Director-General, as the latter office no longer exists.

The following Officers retire from the Committee by rotation, and according to Rule IV. are *not* eligible for re-election:—

Colonel Hardinge, K.H.,	Captain Boxer.
Colonel Bloomfield, R.H.A.	Captain Young.
Colonel Tulloh.	Dr. J. Savage, M.D.

It was then RESOLVED,—

I. That a respectful letter be addressed to the Field-Marshal Commanding-in-Chief, requesting him to permit his name to be enrolled as PATRON and PRESIDENT of the Institution.

II. That Rule IV. be altered as follows:—

The title "Adjutant-General of Artillery" to be *substituted for* "Deputy-Adjutant-General."

"Senior Assistant-Adjutant-General" *for* "Assistant-Adjutant-General."

And "Secretary Ordnance Select Committee," (being an Officer of the Regiment), *for* "Assistant-Director-General."

III. That the following Officers be appointed to the Committee:—

Colonel E. N. Wilford.
Colonel J. Fitzmayer, C.B.
Lieut.-Colonel G. A. Maude, C.B., R.H.A.
Captain H. Clerk.
Major W. H. Simpson.
Captain G. K. Taylor.
Dr. W. A. Dassauville.

The Committee for 1856 will then stand thus:—

PATRON AND PRESIDENT.

Field-Marshal Viscount Hardinge, G.C.B.

VICE-PRESIDENTS.

The Adjutant-General.
The Director-General.
The Commandant.

MEMBERS.

The Senior Assistant-Adjutant-General.
The Secretary Ordnance Select Committee.
The Brigade-Major.

Colonel E. N. Wilford.
Lieutenant-Colonel F. Eardley-Wilmot.
Colonel J. Fitzmayer, C.B.
Lieut.-Colonel G. A. Maude, C.B., R.H.A.

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Captain F. A. Campbell.
Captain H. Clerk.
Captain E. Palmer.
Major H. W. J. Dashwood.
Captain J. B. Parkin.
Major W. H. Simpson.
Captain G. K. Taylor.
Lieutenant T. A. Harrison.
Lieutenant W. L. Yonge.
Lieutenant F. de Winton.
Dr. W. A. Dassauville.
Captain C. W. Younghusband, *Secretary and Treasurer.*

The Report was then adopted.

IV. The Committee submitted the following Resolution:—

The Committee of the Royal Artillery Institution have received an application from the Lieut.-Governor, Royal Military Academy, asking permission for certain Lectures to the Practical Class of Cadets, to be delivered in the Lecture Theatre of the Institution.

The Committee believe that these Lectures will be found highly interesting and instructive, and as Officers will have great facilities in hearing them, recommend that the General Meeting approve of permission being granted so long as no inconvenience is occasioned. It will be clearly understood that the permission so granted can be withdrawn at any time at the desire of the Members.

The Lectures proposed are—

Monday, . .	Mechanics.
Wednesday, . .	Chemistry.
Thursday, . .	Mineralogy and Geology.

From 5 to 6 in winter, and from 6 to 7 in summer.

It was PROPOSED by Lieut.-Colonel Maude, and SECONDED by Lieut.-Colonel Eardley-Wilmot, that the following paragraph be added to the above:—

Notice to be given by the Lieut.-Governor of the Royal Military Academy of the commencement of every separate Course of Lectures, that the Committee may consider the propriety and convenience of continuing this permission.

The Resolution, with the proposed addition, was then agreed to.

V. RESOLVED,—That a copy of the above Resolution (including the added paragraph) be forwarded to the Lieut.-Governor, Royal Military Academy.

The thanks of the meeting were voted to the Committee and to the Secretary for their Services during the past year.

Thanks were also voted to the Chairman, and the meeting adjourned.

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DONATIONS.

LIST OF PRESENTS RECEIVED SINCE THE LAST MEETING.

BOOKS.

The following volumes were presented by His Excellency the Minister of War of H. M. the King of Sardinia.

Regolamento per gli Inventari del materiale d'Artiglieria. Torino, 1848. Part 1. 4to.

Istruzioni sul servizio delle officine di costruzione. Torino, 1846. Parts 1, 2, 3, and 4. 4to.

Specchi delle misure delle Artiglierie Piedmontesi in uso nel, 1852. Parts 1 and 2. 4to.

Istruzione Provvisoria sull'affardellamento, 1852. Lithograph.

Istruzione sul servizio delle officine di construzione Atlante. Torino, 1845. Folio.

Ricordi sul Materiale d'Artiglieria Marina. 1 vol. Genova. 1 part, folio, 12 plates.

Strumenti Attrezzi E. Macchine d'Arti. E. Mestieri. Torino, 1847. 1 part, 34 plates, folio.

Cavalli's Equipaggio da Ponti di Barche. Torino, 1836. 1 part in lithograph. 1 vol. folio, and 2 parts letter-press.

Alcune Nozioni sulle Armi Portatili. Torino, 1851. Small quarto. Lithograph.

Sunto delle nuove cose proposte ed introdotte nel materiale d' Artiglieria durante il, 1848 and 1849. Lithograph.

Comando Generale d'Artiglieria, (orders relating to the above.) 1848.

Ammario d'Artiglieria, 1850-1851. Torino, 1852. 4to. Lithographed, with 7 plates.

Specchi Sinottici delle parti principali del materiale d'Artiglieria, 1852. Torino. Lithograph, 28 plates.

Instruzione per gli Esercizi Ginnastici. Torino, 1849. 8vo., with 17 plates.

Reggimento d'Artiglieria da Piazza. Obice da Montagna da cent. 12. Torino, 1853. Lithograph. 4to.

Reggimento Bocche da fuoco da Campagna. 1852. Lithograph.

Reggimento sul Puntamento e tiro delle boche da fuoco da Campagna, 1853. Lithograph.

Reggimento sulla scuola delle distanze, 1853. Lithograph.

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Dizionario d'Artiglieria de' Capitani Carbone e Arno'. Torino, 1835. 4to.

D'Antonia dell'Architettura Militare. Torino, 1814. 6 vols. 8vo.

Filiberto Appiano Trattato Elementare di Fisica e d'Idromeccanica. Torino, 1818. 3 vols., 8vo.

D'Antoni Instituzioni Fisico-Mecchaniche. Torino, 1815. 2 vols., 8vo.

D'Antoni Il Maneggiamento delle Macchine d'Artiglieria. Torino, 1816. 1 vol., 8vo.

D'Antoni Esame della Polvere. Torino, 1765. 1 vol., 8vo.

D'Antoni dell'Artiglieria Practica. Torino, 1775. 2 vols., 8vo.

D'Antoni dell uso delle Armi da fuoco. Torino, 1780. 1 vol., 8vo.

Manopere di Forza. Torino, 1823. 1 vol., 8vo., with 21 plates.

Course of Mathematics. 5 vols., 1814.

Appiano della Polvere da Fuoco. Torino, 1816.

Ricordi per l'uffiziale d'Artiglieria in Campagna. Torino, 1849. 1 vol., 8vo.

Regolamento delle Instruzioni Practiche dell'Artiglieria. Torino, 1835. vols. 1, 2, 3, 5, and 6.

Monografia delle bocche da fuoco. Genova, 1840-1. 5 parts.

Manuale dell Artificiere del corpo reale d'Artiglieria. Torino, 1830. 1 vol. 8vo.

Specchio delle Robe da Aggiungersi al Modello degli Inventarii del Materiale d'Artiglieria. Torino, 1851. 4to.

Teoria Chimica delle Polveri a Fuoco. Torino, 1852. 1 part 8vo.

Sovrani Provvedimenti e Regolamento del 23 di marzo, 1844, per gli operai dei diversi Laboratorii e delle varie officine dell'Artiglieria.

Regolamento per l'analisi della lega del Bronzo. Torino, 1852.

Norme pel Caricamento degli affusti e carri del Traino da Campagna. Torino, 1853.

M.S.S. Précis sur le materiel d'Artillerie Piemontaise et les modifications principales qu'il a subié jusqu à ce jour.

The following Volumes were presented by Lady May.

Table des Forces de l'Europe composé de 194 Plans des Villes les plus considerables du monde, par N. de Fer. Paris, 1723.

Plans of the attacks upon nine fortified places by the British and Prussian Armies in the Campaigns of 1814 and 1815, by Colonel Carmichael Smyth, R.E., C.B., &c. Cambray, 1817.

Artillerie du Comité, 1830, collection des dessins.

Art. de Campagne, 5 plates.
„ Montagne, 2 „
„ Siège, 2 „
„ Place et de Côte, 4 plates.

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Affût de Mortier, 2 plates.

General Orders of the Army in Portugal, Spain, and France, 1809 to 1817. 9 vols., 8vo.

Officer's Manual, translated from the German. 1800. 2nd edition. 60 plates.

Bormann Betrachtungen über den beschleunigten, Festung Angriff, &c., &c., being a translation of the work of Sir John May on Iron Ordnance. Dresden, 1822.

Four small 8vo. M.S.S. Note Books, on Artillery subjects.

Maps and Plans:—

Plan der Königl. Residenz-Stadt München.

Carte Génerale d'Allemagne par M. Chauchard.

A reduced map of the German Empire from M. Chauchard. London, 1800.

M.S.S. maps of part of Spain. 2 parts.

Plan of the Harbour of Cadiz, by Don Vincent Tofino de San Miguel, 1789. London, 1805.

Faden's Map of Portugal, in three parts, N., Centre, S. 2nd Edition, 1790.

Map of Spain and Portugal, 1808 (Mentelle and Chanlaires).

M.S. of Minorca, surveyed by the French Engineers, 1780.

Carta Militar das principaes Estradas de Portugal; with a few M.S. notes.

Great Map of Spain, in 98 parts, by Don Juan Lopez, 1810.

Portfolio of 17 plates, illustrating the Bavarian Royal Artillery, 1853. *Capt. J. C. Whitbread, Suffolk Militia Artillery.*

Die Feld Artillerie und ihre organisation von J. Hutz. München, 1853. 1 vol. 8vo. *do.*

Handbuch für die Königl. Baverische Artillerie von J. Hutz und J. Schmölzl. München, 1847. 8vo. *do.*

Richardson's Dictionary of the English Language. Pickering, 1836. 2 vols, 4to. *Lieut. J. H. Brown, R.A.*

The following volumes were presented by Lieut. Andrews, R.A.

A Course of Chemistry, &c., by Nicholas Lemery, M.D., 3rd Edition, 1698.

Chymical Lectures, &c., by John Friend, 2nd Edition, 1729.

The Elaboratory laid Open, 1758.

Manual of Chemistry, from the French of Beaumé. 1778.

Chemical Essays, by R. Watson, D.D. 7th Edition. 5 vols. 1800.

A Syllabus of Chemical Lectures. 1811.

Traité de Chimie Elémentaire, par L. J. Thenard. 2nd Edition. 4 vols. 1817.

Corso di Chemica Economica, di Giuseppe Guilj. Firenze. 1818.

Thompson's History of Chemistry. 2 vols. 1820.

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Corso Anal. di Chemica, di G. Mojon. Genova. 2 vols. 1825.
Treatise on Chemistry, by M. Donavon. Cab. Cyclop. 1832.
Brande's Chemistry. 2nd Edition. 3 vols. 1821.
Brande's Pharmacy. 1 vol. 1824.
Statistique de la Suisse. 1819.
Phillips' Geology. 1 vol. Cab. Cyclop. 1837.
Schiller's Don Carlos. 1804.

"The Comet," translated by Col. C. Gold, C.B., R.A. 1833. *Capt. J. H. Lefroy.*
Franklin's Electricity. 5th Edition. 1774. 1 vol. 4to. *do.*
Annals of Natural History. Vols. 4 and 5. 1840. *do.*
Etat actual de l'Artillerie de Campagne en Europe. Artillerie de Campagne Anglaise. 1838. *Lieut.-Col. Eardley-Wilmot.*
Executors of the late Col. Colquhoun, R.A., through Capt. Chapman.
Boletin de Guipuzcoa. March, 1837 to Feb. 1838. Illustrating a part of the Carlist war. *do.*
El Faro de los Pireneos, March, April, and May, 1840. *do.*
Plates from 1, 2, 5, 6, 7, & 8, from the Voyage du Marechal duc de Raguse, relating to Egypt and Syria. *do.*

The following volumes were presented by the Secretary at War to the United States, through Colonel R. Burn.

Ethnological Researches, respecting the Red Man of America; or, History, Condition, and Prospects of the Indian Tribes of the United States, by H. R. Schoolcraft, LL.D. Philadelphia, 1854. 2 vols.
Washington Astronomical Observations, vol. 1, 4to, in sheets, 1846. vols. 2 and 3, sewn.
Maury's Sailing Directions, 2nd edition.
Ditto ditto, 4th ditto
Ditto ditto, 5th ditto
Ditto ditto, 6th ditto
Maury's Abstract Log, and Wind and Current Charts.
Artillery for the United States Land Service, 1849.
Plates to ditto. Royal size.
Uniform and Dress of the United States Army.
Owen's Report of the Geological Survey of Wisconsin, &c. Philadelphia, 1852. 1 vol. 4to.
Illustrations to ditto; with some beautiful specimens of Analyptograph engraving, applied to fossils.
Explanation and Survey of the Valley of the Great Salt Lake of Utah, by Captain Stansbury. Washington, 1853. 1 vol. 8vo.
Report on the Geology of the Lake Superior Land District, by Foster and Whitney. Parts I., II., 8vo. 1850-1.
Exploration of the Valley of the Amazon, by Lieut. Herndon.—Part I. Washington, 1853. Map to ditto.

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New Mexico and California, by Emory, Abert, Cooke, and Johnston, United States Topographical Engineers, &c. 1 vol., 8vo. 1848.

Sitgreave's Report of an Expedition down the Zuni and Colorado Rivers. 1 vol., 8vo, in sheets. 1853.

Andrews' Report on the Colonial and Lake Trade of the United States. 1 vol., 1 part Maps, 1852.

Commerce and Navigation of the United States. 1 vol., 8vo. 1853.

Statistics of the United States. 7th census. 1 vol. 4to. 1850.

Abstract of the Seventh Census. 1 vol., 8vo.

United States Official Register. 2 vols., 8vo. 1853.

United States Post-Office Directory. 1854.

Charter of the City of Washington.

Olivier, G. A., Voyage dans l'Empire Othoman. Paris, 1801. 2 vols. 4to. *Capt. J. W. Jervis, R.A.*

L'Ingenieur de Campagne de Clairac. 2nd Edition. 1 vol. 4to. 1757. *do.*

Military Calendar, 3 vols. *Capt. N. O. S. Turner, R.A.*

List of Light Houses in the United States. *Capt. W. J. E. Grant.*

Regulations of the United States Military Academy. *do.*

Reports of Railway Suspension Bridge over the St. Lawrence. *do.*

Sixth edition of the Artillerist's Manual. *Major Griffiths.*

Two Works on Prussian Artillery, by Kameke.—4 vols. Berlin, 1847. *His Serene Highness the Prince Radziville, through Col. J. Bloomfield, R.H.A.*

One ditto ditto, by Oelze. 1 vol. Berlin, 1853. *do.*

Fritach's Architecture Militaire. 1635. *Capt. Milman, R.A.*

Atlas Portatif Voyageur. Par le Sanson. 1683. *do.*

Burn's Technical Dictionary. *Capt. J. B. Parkin, R.A.*

Notes on the Artillery of the British Army. 1 vol. *The Author, Gen. Sir R. Gardiner, K.C.B., K.C.H.*

Report on Gibraltar. 1 vol. *do.*

NATURAL HISTORY.

Head of Moose Deer. Prepared and presented by *Lieut. T. W. Blakiston.*

Skull and Horns of Moose Deer. *Lieut. W. S. M. Wolfe, R.A.*

Six Specimens of Quadrupeds, stuffed, from New Brunswick, viz., American red Squirrel, ditto Ground Squirrel, Field Mouse, Jumping Mouse, Shrew, and Bat. 81 specimens of birds, consisting of 64 species, killed in New Brunswick, and stuffed by the donor; 4 bottles of Reptiles; Minerals, and Botanical Specimens. Also,

Twenty-four Bird Skins, two bottles with Insects, and one snake, from the Crimea. *Lieut. T. W. Blakiston.*

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Eleven models of Cingalese Boats, viz.:—

1. Yathrawa or Dhoney—Freight or Passenger Boat between India and Ceylon.
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4. Peēta Ooroor, or Fast River or Coasting boat.
5. Wārŏokāng Ooroor, or Deep Sea Fishing boat.
6. Māloo Ooroor. The common boat of the Islanders.
7. Angŏola. Passenger River boat, also used for merchandise.
8. Mādthŭl Părōor. Fishing boat used with nets along the coast.
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A case containing 96 specimens of Woods from the Island of Ceylon. *Lieut. A. Sievwright.*

Small Hortus Siccus of about 100 specimens, collected in Great Britain, Canada, and the West Indies. *Lieut.-Col. J. St. George.*

Specimen of the Bog Head Gas Coal, from Edinburgh *Capt. H. W. Montressor.*

Specimen of Bituminous Lignite, or Fossil Wood, closely resembling Coal, from Weep Hill, near Brighton. *Col. J. Eyre, R.A.*

Twelve sheets of dried Sea Weeds, chiefly from Van Dieman's Land; dried Plants from Madeira, &c. *Lieut.-Col. Eardley-Wilmot.*

Tin containing Manna, from Van Dieman's Land. *do.*

Two Skins of Phaton Athereus, from West Indies. *Col. H. Palliser.*

Collection of Birds' Eggs. *Lieut. W. French.*

Small preserved Fish (Dragonet). *Colonel Poole.*

Collection of Eggs. *Lieut. W. Yonge.*

An Albatros. *Lieut. G. W. Holmes.*

Moose Deer Skin. *Lieut. H. L. Balfour.*

Two specimens of Fan Coral. *Capt. G. H. L. Milman.*

Stuffed Weasel; pair of Horns. *Capt. C. J. Hay.*

Eleven specimens of Cape Wood. *Capt. J. B. Riddell.*

Six specimens of Birds, from Alderney. *Lieut. F. C. Griffin.*

Shells collected by the late Professor Forbes. *The Directors of the Museum of Geology.*

Collection of Land Shells. *Dr. Bird.*

Collection of Botanical specimens. *Col. J. Eyre.*

Two Hawksbill Turtles, from Jamaia. *Lieut. T. Mahon.*

Porcupine Fish; Hypocampus; two Frogs, and two Beetles. *Capt. L. A. Bradshaw.*

Sixty Bird Skins, from Nepaul, Australia, &c. *Mr. Whiteley.*

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MINERALS.

Fossils:—Oolite and Chalk. *Lieut.-Col. A. Tulloh, R.A.*
Mass of Crystallized Saltpetre. *Capt. G. Graydon, R.A.*
A few Fossils from Woolwich Bed; *Paludina, ostra cuniiformis; O. Tenera; Melania Inguinata.* *Lieut.-Col. Eardley-Wilmot.*
A circular Table Top, cut and polished, (diameter 14 inches,) of Septaria, from Weymouth. *Lieut. C. F. Cockburn.*
A small glass case, containing 18 selected Crystals, mounted. *do.*
Specimen Radiated Quartz. *do.*
Specimen Magn. Oxide of Iron. (238) *do.*
Specimen Stalactitie Chalcedony, passing into Opal. *do.*
Fine specimen Crystals of Hornblende in Quartz. (911) *do.*
Fluor, (Baden,) with Quartz. (228) *do.*
Specimen of Stream Gold, in a phial.
The Executors of the late Col. Colquhoun.
Struvite, Ammonio-phosphate of Magnesia, from Hamburg.
Mr Abel.
Sulphate of Soda (Glauberite), natural from Atacama, Mexico, where it is the surface soil to a depth of some inches. *do.*
A few specimens of Minerals. *Capt. R. Oldfield.*
A collection of Fossils, from the Museum in Jermyn Street.
The Directors of the Museum of Geology.
Another collection, from the same Museum, of Minerals and Fossils. *do.*
A fragment of Red Sandstone (carved), from the Palace at Delhi.
Lady Abbott.
A collection of Fossils, and specimens of Building Stone, from Malta and Gozo. *Capt. H. Goodenough, R.A.*

PAINTINGS AND PRINTS.

An oil Portrait of John, Marquis of Granby, Master-General.
The Duke of Rutland.
A curious sketch illustrating a scene at the Royal Military Academy, about the year 1789.
The Executors of the late Col. Colquhoun, through Capt. Chapman.
Portrait of Lord Bloomfield. *Capt. J. W. Domville.*
Water-color drawing, by Gen. Cockburn. *Mr. W. F. Beadon.*
Two sketches; one of Erith, and the other of St. John, Newfoundland, by Lieut. Dames. *Lieut. T. L. Dames, R.A.*
View of the Battle of the Alma, by Capt. Bredin.
Capt. E. G. Bredin, R.A.

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INSTRUMENTS.

An Electrical Machine. *Capt. F. B. Ward.*
Thermometer for determining Elevations, by the boiling point of water; by Dr. Wollaston. *The Executors of the late Col. Colquhoun, R.A.*
A powerful Galvanic Battery (Cullum's). *Capt. H. A. Vernon.*
Two Electro Magnets. *do.*

MISCELLANEOUS.

Revolver; Colt's patent, with modifications by Massachusett's Arm's Company. *The Secretary at War, U. S. Government.*
Five barrelled American Pistol, Leonard's patent, 1849. *do.*
A Mass of Locks, relic of the fire at the Tower of London. *Lieut.-Col. A. Tulloh.*
A South American Machete. *Lieut.-Col. Eardley-Wilmot.*
Skull of a New Zealander. *do.*
Pair of Snow Shoes, from Nova Scotia. *do.*
Model of Chippewayan Snow Shoes. *do.*
Kaffir Utensils; milk basket, three wood tobacco pipes, grass cord, small basket. *do.*
A Turkish Sword, steel scabbard. *do.*
Military relic.—A piece of Lead Plate, from off a Carlist Gun. Irun, 1837. *The Executors of the late Col. Colquhoun.*
Spanish Tangent Scale, peculiar construction. *do.*
Two samples of Wood combined with Gutta Percha, proposed by Thos. F. Forster, Master, R. N., 1851, as a means of making water-proof cases capable of floating their contents. *do.*
A Whip and Thong all in one piece, from the Lace Bark Tree, (Sagetta Sintearia), Jamaica. *Capt. W. T. Crawford.*
A portion of the Inner Bark or Lace of the same tree. *do.*
A Grass Hammock, from South America, the property of the late Major Levinge, R.H.A. *Sir R. Levinge, Bart.*
Specimens of Ingredients used in the Manufacture of Gunpowder. *Capt. G. Graydon.*
Stone Spear-heads. *Lieut. W. S. M. Wolfe, R.A.*
Carved Pipe-stick. *Lieut. F. G. Ravenhill.*
Whip from South America, made from the Lace Tree.
Halter, ditto, Cocoa Nut fibre. *Capt. G. H. Milman.*
Prussian Helmet and three Plumes. *Capt. J. B. Riddell.*
Russian Fuzes and Fougass, from Crimea. *Lieut. H. Thornhill.*
Part of a Case Shot, recovered from the wreck of H.M.S. Amethyst, off Alderney. *Lieut. F. C. Griffin.*
Russian Pouch, with 60 rounds of Small Arm Ammunition, one cap bag with caps, taken off the field of Inkermann; Russian bullets and Cartridges, a broken Bayonet, off the field of Tchernaya. Russian Fuze. *Colonel J. W. Fitzmayer.*

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Russian Tube Box and Tubes, Priming Irons, and Powder Horn, belonging to No. 4 at a Russian Gun. *Major J. Singleton.*

Two Russian Gun Locks, a Tangent Scale and Dispart, and some Tubes. *Major W. Lukin.*

A piece of worm-eaten Wood, from the Artillery Barracks, St. Louis, Mauritius. *Lieut. A. P. Joy.*

A number of Ancient Vases, Cups, &c., from Corfu; and a Bottle, from the wreck of H.M.S. Edgar, off Spithead.
Major-Gen. H. Gordon.

Four pieces of Telegraph Wire Cable. *Capt. A. Drayson, R.A.*

A Glass Bottle, found in the sea off Jamaica. *Col. R. Barker.*

A Turkish Water Bottle (leather), from Bulgaria.
Major J. E. Hope.

A carved New Zealand Paddle, &c. *Capt C. H. Smith.*

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Notes on the Artillery of Belgium.

By Lieut.-Colonel W. B. Gardner, R. A.

The three chief considerations of the Belgian Artilleryman are—the Gun: its emplacement: its transport. The first includes construction and service. The second, its application, or, as we might say in English, putting the right Gun in the right place, and the necessary cover for the Gun when the place is fixed. The third, the march, on which obstacles will be encountered, ravines, rivers, marshes, and other disagreeable things; for the course of warfare is actually rough, more or less, according to the power of overcoming difficulties. Now, as the Belgian Artillery has considerable weights to move, the Government has wisely given to it the means of moving those weights over the obstacles likely to present themselves on service. Hence, let it be supposed that a Belgian 12-Pr. Battery is ordered to march from the gate at the entrance into the Marshes, in a straight line to the Butt, over that impediment, and then proceed to the river and prepare a wharf from whence to embark the Battery, the whole operation would be done without delay, or requisitions.

Anxious to know what were the duties of a Continental Artillery, I made the following notes, when stationed at Liége last summer. As regards material, I have merely noticed the striking difference between theirs and ours. The remarks on recruiting apply to the army generally.

For whatever there may be worth reading in the notes, we are indebted to the Colonel Commanding the 3rd Regiment, Eenens, whose kindness and hospitality I shall ever remember.

Enlistment.

There are two methods of recruiting the army. Firstly, by means of the Militia Law, (the word *Conscription* is no longer used, *Militia* is substituted for it,) and secondly, by voluntary enlistment.

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Militia Law.—The Militia Law is briefly as follows, viz.:—All males who, on the 1st of January have completed their 19th year, are registered for the Militia Service, or, in other words, for the Army. Of this number 10,000 only are annually required in time of peace to keep up the army, and that number is obtained by lot. Those who draw a number above 10,000 have completed their militia engagements for life. For 1856 the number of Registrations was about 38,000.

Contingent.—The Contingent of 10,000 having been medically inspected, the men for the Artillery Service are selected. If the tall, powerful gunners, so common in our service, are almost altogether wanting, there are on the other hand no undersized, weakly, or badly made men. The Artillery Recruits join in November, or when the summer drills and exercises are over, and when the elementary instruction for the ensuing year commences.

Voluntary Enlistment.—Secondly, men may volunteer,

1. After having complied with the requirements of the Militia Law, as in the preceding paragraph, up to the age of 38.
2. Young men between the ages of 16 and 19, who have received such an education as to render their speedy advancement probable, and
3. Militiamen actually serving may contract an engagement.

Length of Service.—The length of service for the Militia is 10 years. Each year represents a class: the five last joined classes form the active classes of the army, the remainder form the reserve. The nominal period therefore of active service is five years; practically, it is but three, a consequence of the army being composed partly of volunteers. By law, the whole of the Annual Contingent *must* pass under arms, and to make room for it, some of the active classes are sent on permanent leave, subject to recall in the event of casualties; at the end of five years they pass into the reserve, which can only be called out by special Act of Government. This sketch of the Recruiting Laws shews that the army can be quickly increased to a very great amount without exertion or expense.

Exemption.—Exemption from the Militia Law is obtained principally,

1. By purchasing discharge.
2. By exchanging numbers before enrolment.
3. By shewing that the support of a family depends upon the exertions of the militiaman, and
4. By procuring a substitute.

Pensions.—After 30 years service the soldier receives a franc a-day as pension: the Non-Commissioned Officers higher in proportion: the Officers serve from 35 to 40 years before they are entitled to a retirement.

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Artillery Officers.—How obtained.—The Officers come from two sources.

(1). From the Military School, at which the Staff, the Artillery and the Engineers are educated, and

(2). From the Ranks.

(1). Cadets enter the Military School at 18. The entrance examination is severe. They remain for two years in the Theoretical School; if then qualified, they select the service they desire to join, and pass into the School of Application. The three services are on a perfect equality, and a free choice is offered to each Cadet in succession, according to standing. As regards pay the Horse Artillery ranks the highest.

The Cadets remain two years in the School of Application, with the temporary rank of Second Lieutenant, there being a separate branch of studies for each service. After passing the final examination they are posted to the Corps they have selected, if there be vacancies in it.

To each Professor at the School there is attached an Officer called a "Répététeur," whose sole duty it is to assist the Cadets in their studies, and ascertain that the lectures of the Professor have been well understood.

It is difficult to form a correct opinion of a Military School from a hasty glance at it; but, apparently there is too much attention given to theory, and more especially in the School of Application, which should be partly practical. At 22 years of age, the Officers join their Corps, having every thing practical to learn. The delineation of ground in pen work, and many of their drawings, would do credit to first-rate engravers; whether this excessive neatness be necessary or even desirable for military men is a question, but it is certain that the eyesight must be impaired in endeavouring to gain it. Officers, on leaving the Military School, join in the first instance a Siege Battery; they afterwards move into Mounted or Horse Batteries, according to capabilities and interest, and, on promotion, revert either to the Siege Batteries, Pontoon Company, or the Establishments.

(2). Non-Commissioned Officers receive Commissions if they pass the requisite examination. There appears to be no great difficulty in the Non-Commissioned Officer obtaining a first Commission, and he receives every assistance in the Regimental School to enable him to do so, but he is not further promoted without passing a subsequent and severe examination. As a general rule it would appear that promoted Non-Commissioned Officers, after a time, prefer siuations "en résidence," answering to those of Deputy-Storekeeper and Master-Gunner with us, or they go into the Train or Depôt Companies.

Promotion.—The general rule of promotion is by seniority. The King, however, promotes any Officer specially recommended. The promotion goes in the whole Corps of Artillery, and not by Regiments.

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The Establishments.—The Establishments are mentioned chiefly to shew the connexion of the *personnel* of the Artillery with them. A detailed account is altogether beyond the limits of an "occasional paper." Officers, on reaching the rank of Second Captain, go at once into the Establishments, and there remain until promoted.

Gun Foundry.—The Liége Royal Foundry is well known on the Continent. Spain, Austria, and lastly, England, have availed themselves of Belgian experience. Austria, in 1851, adopted the Liége Process of Fabrication, and the whole system of mechanical proofs. Rather than allow the work to stagnate during peace, and, their own wants being moderate, the Belgian Government cast for foreign powers; and, accordingly, between 1840 and 1854, they furnished to other Governments 2,765 guns; and of 274 pieces cast in 1854, none were rejected. They can turn out about 300 guns a-year.

The Staff is composed of one Inspector, a Superior Officer; one Major, Assistant-Inspector; one Captain, and two Lieutenants, Storekeepers, &c. The Workmen are chiefly civilians. The *Course* in the Gun Foundry, by Major Coquilhat, is a most valuable publication.

The Small Arm Department.—The Small Arm Department is formed for three purposes: it supplies arms to the State, trains Armourers for the Regiments, and Officers for inspecting the arms of the Regiments of Cavalry and Infantry; an annual duty performed here invariably by the Artillery Officers. In addition to the ordinary "view" of Small Arms, five rounds are fired from each piece before it is issued, and a diagram of the shooting preserved. If the five shots do not strike within a certain specified distance from the centre, the piece is rejected, however perfect it may be in every other respect. The Staff is composed of one Inspector, a Superior Officer; one Major, Assistant-Inspector; and three Captains, together with one Company. (See table No. 9). There are also a number of civil workmen. The printed *Course* by Captain Gillion, is a most useful work.

The Carriage Department.—There is little or no machinery in the Carriage Department, and the whole is on a very small scale as compared with ours. There are three objects sought by this department, viz.:—The supply of carriages, the training of artificers for the Batteries, and the practical instruction of Officers for superintending branch establishments in war time. The Staff is, an Inspector, a Superior Officer; a Major, Assistant; two Captains or Lieutenants, and a company of Artificers. (See table, No. 8).

The Laboratory.—The Laboratory is on an equally small scale, and the machinery used is chiefly portable. The Staff is composed of a

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Superior Officer, as Inspector; two Captains, two Lieutenants. There are 40 Non-Commissioned Officers students, and 40 Gunners detached for three years from the different Batteries, and a number of Artificers, Sergeants. There are no civilians employed in this Department. (See programme of Summer and Winter duties.)

The Store Department.—The Store Department as the Laboratory, is a military department. The harness and saddles are manufactured in it. There is a small foundry for repairs, &c. Woodwork in store is simply oiled, not painted. In this department are also the Packed Batteries for service. The Staff of Officers is a Major and one Lieutenant.

Gunpowder.—Gunpowder, when required, is furnished by contract. In this case an Officer resides on the spot, and superintends its fabrication.

From this brief notice of the establishments, it is evident that Belgium (a small, and by no means a wealthy state), employs in the manufacture of its war material a larger Artillery Staff than England does with her standing army, her ships, colonies, and dependencies; that the establishments are more military than ours are, and that the experience gained in them is more widely spread amongst the Officers of the corps, from the circumstance of the Second Captains being always employed in them.

Uniform.—There is but one uniform for the whole corps, with slight modifications for mounted and dismounted men. The former, namely, the Horse Batteries, the mounted Non-Commissioned Officers, Trumpeters and Drivers of Mounted Batteries and the Train, have their trousers strapped with leather, and wear boots and spurs; the latter wear shoes. The whole dress is upon the French model, and is soldierlike and serviceable. The clothing is made up by the regimental tailors: the coatees separately for each man; the trousers in sets, according to the established pattern; the latter are of most ample dimensions as regards width. The belts are white. The Trumpeters are distinguished by yellow epaulettes, cap lines, and braid; the remainder have red. Officers are never seen out of uniform, or without their swords. Their belts are black.

Regimental instruction of the soldier, see programme.

The Gunner.—The training of the Gunner is thus divided:—

1. Gymnastic exercises.
2. Setting up.
3. Squad-drill, and preliminary Sword Exercise.
4. Field Gun Drill.
5. Garrison Gun Drill.
6. Theories.

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The Driver.—The three first heads of instructions are as for the Gunner, with this difference, that as the object is to place him on horseback as soon as possible, less time is allowed for the second and third.

4. Riding.
5. Driving.
6. Theories.

The Driver can serve the gun on an emergency, but the Gunner is not taught to ride until it be a question of promotion to the rank of Non-Commissioned Officer.

Riding and Driving School.—When the riding of the recruit is perfect, he passes into the driving class. Beginning with a pair of horses harnessed; he proceeds to drive a pair in draft, next as forming part of a team of four or six, and finally two guns, or a division are worked together; the whip is suspended from the right wrist, and is very seldom used or even seen. The Riding School is of sufficient dimensions to allow of six guns with teams of six, working in it at once; this has reference to Liége only. That of Malines is of smaller dimensions. Each Regiment has a school of its own. That an Artillery force of four Horse, and fifteen mounted Batteries, should have four riding schools contrasts remarkably with our *one*.

The School is light, lofty, and well ventilated. The flooring of earth and tan, is laid upon a base of concrete, and is ploughed and raked occasionally. All horses are broke for riding before draught. The system is that of Baucher, which was introduced into England about three years ago by the late Captain Nolan, but has never been adopted by us as a system.

Superintendence of Instruction.—The Captain and Adjutant-Major superintends foot parades, gun drill, and schools for theory: the riding, driving, and gymnasium is superintended by the Captain or Lieutenant-Instructor. The general rule is to have as small squads and as many instructors as possible, and every drill includes a certain amount of theory, which is given about the middle of the lesson.

Duration of Preliminary Instruction.—The gunner recruit receives altogether about 174 lessons, thus divided, viz.:—Setting up 21. Squad-drill 18. Field Guns 75. Siege Guns and Repository Exercises 60, which, at the rate of two exercises per day, would give about three months for preliminary instruction. The course for the Driver lasts about six months, and for the Horse Artilleryman about twelve months. At the end of the course of preliminary instruction, the recruits, if qualified, are inspected by the Colonel, and pass into the hands of Captains of Batteries, who then become responsible for them.

Schools for Theories.—The accompanying programme of duties and

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drills for this season, shews the hours of attendance at the schools. There is a special course of Instruction for the Non-Commissioned Officers, candidates for commissions. Lectures upon material, veterinary science, &c., are also given. Models of Machines used in the Repository course are worked, and Model Batteries are made in sand, so as to prepare Non-Commissioned Officers for the practical instruction of the Polygon.

The Polygon.—The Polygon, which is situated near Antwerp, and in the middle of a large heath, is the great school for practice, and generally, for those Artillery exercises, (pontooning excepted,) which cannot be taught in Barracks. The period of instruction is from June to September, and each mounted and Siege Battery remains for fifteen days under constant instruction. The Horse Batteries remain only three or four days.

Staff of the Polygon.—The Staff undergoes no change during the season, and is composed of a Major as Commandant, assisted by two Captains, one of whom he has the privilege of selecting, the other is one of the staff of the preceding year. There is also a Captain Director of the Park, a Medical Officer, a Veterinary-Surgeon; and a Committee of four Captains, whose sole duty is to conduct the experiments directed to be carried out by the General-in-Chief of the Artillery.

Barracks and Stables.—The Barracks and Stables are of masonry. The Officers mess together.

Employment of Batteries.—All kinds of practical work connected with the Artilleryman's duty is carried on: for example—enfilading and breaching Batteries are constructed, gabions, fascines, expense magazines and blinded Batteries are made, and Platforms for all natures of Ordnance are laid.

Practice.—The Practice is divided into two chief classes—ordinary, to teach pointing and laying, the different kinds of practice, the use and application of all natures of Ordnance and Projectiles, and "*Tir de Guerre*," for the estimation of distances, and the habit of observing the effect of the projectile. Very detailed records of all practice are kept. The "*Tir de Guerre*," with a Mounted or Horse Battery, takes place after a forced march. The Battery comes into action at various distances against targets, representing Cavalry and Infantry, and shifts position according to the orders of the Commandant, who directs also the nature of the projectile to be used. Notes are made of the time required to fire and to change position. The effect produced, as well as the general state of the Battery, determine the class of merit eventually assigned to it.

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Siege Batteries.—A like process is gone through with a Siege Battery, Heavy Ordnance being used instead of Field; in addition to this, each Captain of a Siege Battery has to construct and arm either an enfilading, breaching, or blinded Battery, with Expense Magazine, &c. He draws his material from the Park, and employs his officers and men according to their capabilities, and is entirely responsible for the whole operation.

Ammunition Expenditure, 1855.—In 1855 the following number of rounds were fired at practice, viz.:—3,711 Round Shot; 1,688 Shrapnels, and 6,035 Shells from Howitzers and Mortars. In experiment 2,416 projectiles were expended.

Prizes.—At the end of every season prizes are publicly distributed to those men who have distinguished themselves in pointing or laying.

Experimental Practice.—The experimental practice affords solutions to scientific Artillery questions. The following subjects have been lately investigated, viz.:—Rules for Shrapnel Shell firing, which is here supposed to have reached great perfection, and which has led to a change in the proportion of Shrapnel to Solid Shot in the provision for Field Guns, the graduated metallic Fuze, the verification of tables of ranges, the due proportion of the Weight of the Gun to its Travelling Carriage, and the investigation of circumstances which exercise an influence upon initial velocities. For the determination of initial velocities, the *electro ballistic* apparatus of Captain Narvez of the Belgian Artillery, is used. First tried in 1848; it has now become the standard instrument in Belgium, and has been finally adopted by the French Artillery, at Metz. They have also investigated the subject of incendiary Shrapnels, which form a part of the ammunition of Field Howitzers, elongated cartridges, different forms of, and materials for "*ensabotage*," and instruments for pointing. There are other questions of equal importance still under investigation, such as rifled and breech loading Guns of large Calibre; (it may be mentioned that the trials of Wahrendorf's Gun have been quite successful:) Disc Shot, the ranges with which at low angles have been enormous, though the lateral deviations very great; eccentric Shells from Mortars; practice against iron-covered constructions, representing Floating Batteries, with forged Shot, (iron plates of 4½ or 5 inches thick, were perforated, and the woodwork behind destroyed by 36-Prs. at a distance of about 650 yards), and the resistance offered by various forms of blindage to Shells and Shot. This last experiment appeared to have been conducted with great care. All natures of wood, sections, and scantling, seem to have been used, and most ingenious combinations of fascines, timber, earth, &c., tried.

Polygon formed for three objects.—The exercises of the Polygon serve

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three ends; they furnish a test of the manner in which a Captain has drilled and instructed his Battery during the preceding season; they are a direct source of practical instruction, and they determine the value of divers projects connected with arms. The time each Battery is under instruction may appear to be short, but the work is incessant.

Brigade Drill.—Brigade Drill, and everything connected with the tactics of Artillery, or in relation to the other arms of the service, and all that relates to camp duties, hutting, cooking, making roads, &c., is carried on during the summer months at the general camp at Beverloo.

Pontooning.—Pontooning and the construction of temporary bridges is here a regular part of the Artilleryman's duty. The Pontoon Company exercises daily on the Meuse, either with Pontoons, flying or trestle bridges, and occasionally accompanies the garrison during a field-day. The advantage of having a permanent and well drilled body of bridge-makers connected with the Artillery is obvious: their services are available, not only in crossing rivers, but also in forming temporary wharfs, bridging chasms, and rapidly overcoming those obstacles which may be, and often are, serious impediments to Artillery, but which are easily surmounted by Cavalry or Infantry. The transport of the heavy Ordnance lately introduced, and being introduced into the service, except upon the best roads, is no easy matter, and would seem to indicate the necessity of giving to the Artillery in itself, increased means of overcoming difficulties of ground. The "Belgian Trestle," which is noticed elsewhere, appears to offer the means of doing so. The Pontoon Company is particularly smart: when they move, their material is horsed by the train.

It may be remarked that the Belgian bridge assumes fixed supports as the base of the system, floating supports being only complements of the others. The plate exhibits a novel application of a bridge. In the course of some manœuvres in 1855, it was necessary to move two *Corps d'Armée* at the same time. Their routes crossed, and one or other must have delayed its march. The Artillery in a very short time constructed a bridge, as shewn in the plate, and the passage of the two corps went on uninterruptedly. But it is in arming Batteries during Siege operations, that the Belgian Artillery would reap such advantages from the bridge.

There are many matters under consideration which have not yet been experimented upon, such as the Cavalli proposition of increasing the strength of Gun Detachments by Artillery Riflemen, so as to render the Artillery less dependant upon the support of Infantry, and more capable of meeting the attacks of Riflemen; also the necessity of giving to Artillery greater mobility by mounting the Detachments upon light two-wheeled cars, the construction of the present Limber, &c.

MATERIAL.—Saddles, and Harness.—There is but one pattern.

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The whole is black, even the saddle, and the pole and swingletree being universal, the harness is fitted for it. The breeching strap is carried round over the collar, and is there buckled to the pole strap. An iron bar fixed to a ring moving freely on the pole, is attached to the collars of the wheel horses, but so as to allow considerable horizontal play. The traces of the leading horses pass directly to the swingletree on the splinter-bar, and are prevented from falling when slack by passing through two long loops in the collars of the wheelers: the belly-bands are buckled tight, thus the traces are kept at a good angle for draft, and the collar is retained in its place. The traces are covered only where they come in contact with the horses' side—no winkers; the collars open from the bottom. The hames are covered with leather, other iron-work is black leaded. The horses of the Trumpeters and Non-Commissioned Officers are fitted with the breast-strap; off horses have side reins; but the bearing rein is not used. The saddle is of a peculiar construction and is without pannels, consequently the blanket must be always used. The new pattern saddle was first introduced into the Artillery in April 1848, the harness in 1849. The advantages claimed for the saddle are lightness, durability, strength, and cheapness, that it sits better on the horses' back, is more comfortable for the rider, more easy for the soldier to mount upon, or to dismount from, and chiefly, the tree being fitted with moveable bearings, its power of adjusting itself to any horse. Formerly, sore backs were not uncommon, at present, they are not known. The saddle, complete, weighs about 31 lbs.; its price about £1 12*s*.

Set of Leading Harness, complete, 51 lbs.
„ centre „ „ 52 „
„ wheel „ „ 64 „

There is but one girth, broader and stronger than ours, made by the drivers themselves of cord formed into a kind of "sennet." The harness of the off horses is precisely the same as that of the near, the stirrup leathers and stirrups being, however, carried in the store wagons. There is no such thing as a pad for off horses. The harness is that generally known by the name of the "Flemish Pattern."

Travelling Carriages.—The Field Carriage formerly used was the English pattern. The Piedmontese system has been since adopted in its general principles. The name of the new pattern is "*Affût Bifurqué.*" The properties claimed for it are three, viz.:—lightness, strength where most needed, and reduction in the height of the Gun above the ground, thus bringing it more within the reach of the man of moderate height, and lowering the centre of gravity. The cheeks of the carriage are produced until they meet at the point of the trail; the trail is therefore hollow, except where the transom is placed to receive the elevating screw; the depth of the cheeks under the trunnion holes is greater than

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in ours; the axletree passes through the cheeks and not under them; the bed is rounded in front and on the upper surface, and is connected with the axletree by three bands. There are no travelling trunnion holes. The firing more to the rear than ours are. One man can easily limber up and unlimber. The head of the elevating-screw, which is independent of the Gun, is fitted with a buffer—no breast chains. The shoe is carried in a loop under the axletree. The recoils with the new carriage are acknowledged to be rather greater than with the old; one of the cheeks struck by shot, the whole carriage would *probably* be disabled. After firing from it 1241 rounds of Shrapnel, it was found uninjured. The horizontal dimensions of the axletree are 5½ inches for the 6-Pr., all axletrees are in one piece. Unlimbered, the trail forms an angle of about 20° with the ground. The scantling of the wood being smaller, the price of the carriage is less than in the old one. The 6-Pr. carriage is 1½ times the weight of the Gun. The branched trail was adopted in 1843.

The Sponge.—The sponge is formed of bristles, and is supposed to clean the Gun and resist damp better than ours, and be more easily repaired.

The Handspike.—The handspike fitted with a ring at the end, is a straight lever, works on a hook, and is not shipped or unshipped except for repairs.

The Limber-Box.—There is but one limber-box, and it is placed well to the rear, so as to take the weight off the horses. The lid is curved and covered with zinc; the box is retained in its place by bolts and keys, not lashings. It is divided into partitions, crosswise, of sufficient width to allow the shot to enter freely. The ammunition is not packed in cartouches.

Number of Rounds.—The 6-Pr. box carries 62 rounds of ammunition, viz.:—

Round Shot	24
Shrapnel	24
Case Shot	14
	62

The limber of the wagon contains the same quantity. The wagon body contains

Round Shot	89
Shrapnel	89
Case Shot	42.

The 6-Pr. therefore takes into the field 220 rounds, of which the Shrapnel and Round Shot are in the same proportions. Weight of cartridge

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2·2 lbs. The 12-Pr. Howitzer box 32 rounds of 2·2 lbs.; the 12-Pr. Gun Limber contains 8 Case, 12 Round, and 12 Shrapnel, and 32 rounds of 4·4 lbs; with its wagon 128 rounds, of which 52 Shrapnel. The 12-Pr. Howitzer with one wagon takes into the field 120 rounds. The prolonge hangs on two hooks in rear of the limber axletree—the splinter-bar is very short.

Natures of Field Carriage.—There are two natures of Carriage for Field Artillery, namely, the 12-Pr. Gun and 24-Pr. Howitzer, and 6-Pr. Gun and 12-Pr. Howitzer. The axletree arms are the same in both natures, and the wheels are the same, the tire of the 12-Pr. being only a little wider than that of the 6. The wheels have rather less dish than ours; the naves are smaller, the spokes thicker; there are two additional hoops on the nave, one on each side of the spokes: ring-tires are used.

Tangent Scale.— The scale for elevating is a brass plate cut into steps, when not in use it reposes in a pocket on the side of the left cheek. Using the notch on the muzzle, the steps on the scale give respectively 1000, 1200, and 1500 paces. The line of metal is 800; for distance less than that given by the line of metal, a piece of wood called a "controlleur" is placed on the neck of the piece, for intermediate distances the elevating screw is turned $\frac{1}{6}$, $\frac{1}{4}$, or $\frac{1}{3}$ for every 100 paces, according to the degree of elevation. The whole method of pointing would appear to be rude and complicated, and requires two men.

Ordnance.—The 12-Pr. Batteries of Reserve are composed of 8 12-Prs. Of divisions, 6 12-Pr. Guns, and 2 12-Pr. Howitzers, and the 6-Pr. Batteries of 6 Guns, and 2 12-Pr. Howitzers. The Howitzer Batteries of 8 12-Pr. Howitzers. There is no intermediate Gun resembling our 9. The chambers of Brass Howitzers have been long suppressed. The additional strength is given on the exterior. The Batteries have only 6 Guns in peace.

Gun Detachments.—Mounted Batteries.—For the 12-Pr. the detachment consists of the mounted Non-Commissioned Officer, a Corporal, and seven Men. The 6-Pr. has two men less. Every Gun has its mounted Non-Commissioned Officer. The general position of the detachment limbered up is in the order of march, at reduced intervals in rear. The Horse Artillery have no limber gunners, and the detachments are always in rear. Two of the numbers answering to Nos. 3 and 6 with us, carry a small cartouche, and supply the Gun alternately with ammunition from the limber. The Corporal serves the vent, primes, and elevates; another number standing at the point of the trail gives the direction. In firing, the lanyard is drawn well down.

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Provision is made for carrying five numbers if the Gun has to move quickly, viz.:—three on the limber-box and two on the gun-axletree. The knapsacks of the gunners, much smaller than ours, are sometimes carried on the footboard of the limber, and sometimes by the men.

Posts of Officers and Non-Commissioned Officers.—In line, at full intervals, or in column, the Subaltern Officer is in the centre between his Guns in line with the leaders. In advancing, a little in front; at close intervals in front; in column of route on the flank between his Guns. On bringing his division into an alignment he moves rapidly to the front, goes about and halts them a horse's length short of the final position. After a pause, the leaders of Guns move forward into line, and at the command "Aux Guides" the Guns advance upon their leaders. The Gun leaders are always on the pivot flank in line with the leaders, they are responsible for distances and correct marching, and they give the word to the Gun when it moves separately. There are no markers. The Second Captain on service is in charge of the wagons, which are never brought under fire, and his duty is to keep up a communication with the Battery. The Trumpeters are all well mounted, and are men.

Manœuvering.—The absence of wagons simplifies all movements; much of the drill is in inverted order and at diminished intervals. If the Battery is to come into action to the front, the Guns reverse, and the trail is dropped; the limber then moves on just sufficiently to clear the recoil and halts. It is acknowledged that with the 6-Pr. the Gun is sooner brought into action according to our plan, if the ground be good; but, if the contrary be the case, or there be much limbering up and unlimbering, it is considered better to save the men and throw a trifling addition of work on the horses, and therefore the principle of coming into action to the rear has been adopted. All limbering up is to the rear, the limbers backing. In taking ground and reversing, the leading horses passage more than ours do. The training and steadiness of the drivers and horses is very remarkable. The gunners are cool, but have not the smartness of ours. The words of command are not repeated so much as with us, consequently there is less noise, and the tone of the executive words is better proportioned to the extent of command.

Horses.—The sum allowed for the purchase of horses, £22, suffices now to find serviceable, but not always showy animals. Their general stamp is, however, very good. They are small but powerful, hardy, and very intelligent. There is a prejudice against the careful grooming adopted in our service, as tending to render the animal delicate.

Laboratory.—Bottoms are made of coarse paper rolled round a "former."

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When the requisite diameter is obtained, the cylinder is cut into lengths, one end of each is impressed upon the shot until the paper takes the desired form. The superfluous part is then cut off, and the bottom is connected with the shot by two cotton bands, which pass over the bottom, and are secured to a grummet. The advantages of the paper bottoms are stated to be preservation of the bore, and lightness in transport; greater and more regular initial velocity. No danger to riflemen in front, or men in advanced batteries, and $\frac{1}{3}$ of the price of the wood. They have been 10 years in use.

Fuzes.—Common, of *Wood*, resembling ours. *Concussion*, fitted with a plaster of Paris arrangement in the interior. *Shrapnel, metallic*, invented in 1835 by Lieut.-Colonel Borman, in general form conical. When placed in the fuze hole the exterior is flush with the surface of the shell. When the shell bursts, the fuze furnishes a projectile weighing about ·4 lb. The composition is inserted by pressure into the fuze, and is connected by quickmatch with a "petard" at the bottom of the fuze. The fuze is then covered at the top with sheet lead, and the part immediately over the canal is divided into 14 divisions, each representing half a second of time. The fuze is primed with fine powder and quickmatched. Placed in the fuze hole, it rests on a shoulder and is secured, water tight, by cement. After the musket balls are placed in the shell, swan shot are shaken in, and finally, the bursting powder. In this state the shell leaves the store or laboratory. To prepare it for action, the fuze is simply bored into with a small auger at the desired distance, and the priming loosened. The operation is very short.

Case Shot, $1\frac{1}{3}$ times the weight of the Solid Shot, 41 Balls about $\frac{1}{3}$ of the diameter of the ordinary projectile. The space between the Balls is filled with sawdust. The Balls are placed one immediately over the other.

Tubes.—The Tubes are copper and friction.

Cartridges are made of a coarse kind of silk, which, from its close texture, retains the dust of the powder, in travelling, better than serge does, and suffers less in store from the moth.

Standing Carriages.—"*Affût de place-cote*," a traversing platform complete: The carriage with open cheeks, upon the French principle, appears to want strength. The front axletree is fitted with wheels, the naves of which work on the side pieces of the platform. The spokes and felloes are of iron. The rear transom works on a centre directing bar; the wheels serve to run the Gun up, to regulate the recoil and to move the Gun about the works if it should be necessary to do so: the

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platform traverses on a front pivot, and has two hind trucks. The advantage of this system appears to be the power of quickly mounting and dismounting the Gun, and by means of a limber transporting it about the works, but as a traversing platform, and for rapid service of the Gun, it does not appear to be equal to our dwarf or Naval slide. The English Garrison Carriage is very seldom used as wanting mobility; the Siege Carriage is substituted for it.

There are two natures of traversing platforms, viz., for the 24, 18, and 12-Prs., and for the 36 and 48-Prs. and 8-Inch Guns.

The Siege Carriage has the block trail, and in its general principles resembles our carriage for field service: the limber wheels are higher than ours.

Tangent Scale for Garrison Guns is portable, and resembles our wooden tangent scales. There is a plummet and line attached to the upper part.

Organization of the Belgian Artillery. Royal Decree, 4th June, 1842, No. 4500.

Article 1. General Staff.
2. General Staff.
4. Regiments bearing the No. 1, 2, 3, and 4.
1. Company of Pontoniers.
1. Do. Artificers.
1. Do. Armourers.
2. Do. the Train.

Article 2. The Artillery Staff shall be composed according to Table No. 1.

Article 3. No. 1 Regiment shall be composed of:—
1 Staff.
4 Horse Batteries.
6 Siege Batteries.
1 Depôt.
and each of the Regiments 2, 3, and 4 of:—
1 Staff.
5 Mounted Batteries.
6 Siege Do.
1 Depôt Do.

Article 4. The Composition of the Staff of a Regiment, of the different Batteries, of the Depôt, of the Company of Pontoniers, of Artificers, Armourers, and Train, is fixed according to the scale in Nos. 2, 3, 4, 5, 6, 7, 8, 9, 10.

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No. 1.—COMPOSITION OF THE STAFF.

Grades.	Peace Establishment		War Establishment		
	Men.	Horses	Men.	Horses	
Lieut.-Generals, ...	1	4	1	6	Commanding.
Major-Generals, ...	2	3	2	4	One of these Officers makes the Annual Inspection of Artillery.
Total, ...	3	7	3	10	
OFFICERS.					
Colonels, ...	4	8	4	12	Employed in the 4 directions or districts of Artillery, in the Arsenal, in the Gun Foundry, in the Small Arms Dept. Powder Factory, if there is a contract Laboratory Staff.
Lieut.-Colonels, ...	5	5	5	15	
Majors, ...	5	5	5	10	
Captains. 1st Class, ...	5	5	5	10	
Captains. 2nd Class, ...	5	...	5	10	
Lieutenants, ...	9	9	9	18	
Lieutenants Commandants of Artillery Resident. 1st Class,...	5	...	5	...	
Lieutenants Commandants of Artillery Resident. 2nd Class,...	4	...	4	...	In the Military Schools as Instructors, &c.
Lieutenants Storekeepers. 1st Class, ...	7	..	7	...	
Lieutenants Storekeepers. 2nd Class, ...	8	...	8	...	
Lieutenants Storekeepers. 3rd Class, ...	9	...	9	...	
Total, ...	61	32	66	75	
NON-COMMISSIONED OFFICERS.					
Conductors of Stores. 1st Class, ...	11	...	11	...	
Conductors of Stores. 2nd Class, ...	11	...	11	...	
Conductors of Stores. 3rd Class, ...	12	...	12	...	
Master Artificers, ...	3	...	3	...	
Viewers. 1st Class, ...	3	...	3	...	
Viewers. 2nd Class, ...	4	...	4	...	
Foremen. 1st Class, ...	3	...	3	...	
Foremen. 2nd Class, ...	1	...	1	...	
Total, ...	48	...	48	...	

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RETURN

OF THE

DAILY AMOUNT OF SHOT, SHELL, AND OTHER OFFENSIVE ARTILLERY PROJECTILES, THROWN INTO SEVASTOPOL BY THE BRITISH SIEGE TRAIN, ASSISTED BY THE NAVAL BRIGADE, DURING THE WHOLE SIEGE.

COMMUNICATED BY COLONEL ST. GEORGE, C.B., ROYAL ARTILLERY,
Commanding Siege Train.

The detailed return has reference only, as a general rule, to the expenditure of the ROYAL ARTILLERY of the SIEGE TRAIN, from whom alone *regular* Morning Reports were received. During the month of August, however, till the 5th of September, daily reports of expenditure were rendered by the Officer Commanding the NAVAL BRIGADE, which expenditure is included in the detailed return.

From the number of rounds expended during the Siege, the number in this detailed daily return is deducted, and the remainder has been expended by the NAVAL BRIGADE in addition.

J. ST. GEORGE, Colonel.

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EXPENDITURE OF AMMUNITION,

Guns.

Date. 1851.	68-Pounder.					32-Pounder.					24-Pounder.					10-Inch.		8-Inch.		Lancaster	9-Pr. Field.
	Round Shot.	Common Shell.	Shrapnel.	Case.	Grape.	Round Shot.	Common Shell.	Shrapnel.	Case.	Grape.	Round Shot.	Common Shell.	Shrapnel.	Case.	Grape.	Hollow Shot.	Shell.	Hollow Shot.	Shell.	Shell.	Rounds.
17 October.	...	...	...	...	...	...	...	...	...	...	2855	...	...	...	...	...	...	1429	360	83	...
18 ,	124	...	96	12	...	...	...	...	...	...	3000	...	...	...	...	...	...	821	454	44	...
19 ,	...	...	18	...	...	...	...	...	...	...	2349	...	...	...	...	...	...	423	428	38	...
20 ,	...	...	72	...	...	...	...	...	...	...	1420	...	94	82	...	...	...	341	388	9	...
21 ,	50	...	2	...	...	...	...	...	...	...	954	2	1	...	...	...	...	206	593	...	...
22 ,	40	40	35	...	...	...	...	...	...	...	1406	...	...	...	...	...	...	124	836	...	...
23* ,	...	...	...	...	...	...	...	...	...	...	1569	...	...	...	...	...	...	20	572	23	...
24† ,	...	...	...	...	...	...	...	...	...	...	750	...	...	...	...	...	...	89	258	...	...
25 ,	...	...	...	...	...	...	...	...	...	...	691	20	...	...	...	...	...	167	140	...	...
26 ,	...	...	...	...	...	...	...	...	...	...	855	...	...	...	...	...	...	35	193	5	...
27 ,	...	3	...	...	...	23	...	...	...	...	669	...	5	...	...	...	...	57	86	...	...
28 ,	...	...	...	...	...	49	...	...	...	...	576	...	...	...	...	...	...	56	143	...	...
29 ,	...	...	...	...	...	91	...	...	...	...	368	...	...	...	...	...	...	78	73	...	...
30 ,	...	...	...	...	...	154	...	...	...	...	597	...	...	...	...	...	...	149	6	...	...
31 ,	...	...	...	...	...	44	...	...	...	...	314	...	3	...	...	...	...	158	11	...	...
Total, ...	214	43	223	12	...	361	...	...	...	...	18371	22	103	82	...	...	...	4153	4541	202	...
1 Novem.	...	...	...	...	...	129	...	...	...	...	569	...	5	...	...	...	...	115	14	...	...
2 ,	18	...	...	...	...	150	...	2	...	...	401	...	4	...	...	...	...	222	32	...	...
3 ,	...	...	...	...	...	60	...	...	...	...	412	...	4	...	...	...	...	124	12	...	...
4 ,	...	...	...	...	...	73	...	...	...	...	355	2	10	...	...	...	...	123	36	...	...
5 ,	...	...	...	...	...	65	...	...	...	...	571	...	10	...	...	...	...	188	2	...	...
6 ,	...	...	...	...	...	102	...	...	...	...	481	...	2	...	...	...	...	145	16	...	...
7 ,	...	...	...	...	...	90	...	...	...	...	415	...	4	...	...	...	...	157	24	...	...
8 ,	...	...	...	...	...	45	...	...	...	...	346	...	10	...	...	...	...	111	16	...	...
9 ,	...	...	...	...	...	76	...	...	...	...	298	...	5	...	...	...	...	160	12	...	...
10 ,	...	...	...	...	...	30	...	...	...	...	178	...	1	...	...	...	...	135	9	...	...
11 ,	...	...	...	...	...	29	...	...	...	...	251	...	3	...	...	...	...	72	19	...	...
12 ,	...	...	...	...	...	75	...	...	...	...	301	...	12	...	...	...	...	116	20	...	...
13 ,	1	6	...	...	...	99	6	...	...	...	79	...	...	...	...	...	...	55	8	...	...
14 ,	...	...	...	...	...	...	...	...	...	...	18	...	...	...	...	...	...	9	...	...	...
15 ,	...	...	...	...	...	9	10	...	...	...	53	2	...	...	...	...	...	17	16	...	...
16 ,	...	...	...	...	...	6	2	...	...	...	19	...	...	...	...	...	...	2	...	...	...
17 ,	...	...	...	...	...	11	9	...	...	...	37	...	...	...	...	...	...	5	...	...	...
18 ,	...	...	...	...	...	3	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...
19 ,	...	...	...	...	...	5	...	...	...	...	7	...	...	...	...	...	...	3	1	...	...
20 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
21 ,	...	...	...	...	...	...	...	...	...	...	7	...	1	...	...	...	...	...	4	...	...
22 ,	...	...	...	...	...	...	...	...	...	...	18	...	...	...	...	...	...	...	...	...	...
23 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
24 ,	...	...	...	...	...	12	5	...	...	...	...	...	...	...	...	...	...	...	...	...	...
25 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
26 ,	...	...	...	...	...	5	17	...	...	...	7	...	...	...	...	...	...	3	2	...	...
27 ,	...	...	...	...	...	5	5	...	...	...	3	...	...	...	...	...	...	...	...	...	...
28 ,	...	...	...	...	...	3	2	...	...	...	...	...	...	...	...	...	...	1	...	...	...
29 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
30 ,	...	...	...	...	...	...	...	...	...	...	5	...	...	...	...	...	...	3	...	...	...
Total, ...	19	6	...	...	...	1082	56	2	...	...	4831	4	71	...	...	...	...	1767	243	...	...

* Capt. Childers, killed. † Major Young, wounded.

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MEN, AND MATERIAL.

24-Pounder Rockets.	Mortars. 13-Inch. Shell.	13-Inch. Carcasses.	10-Inch. Shell.	10-Inch. Carcasses.	8-Inch. Shell.	8-Inch. Carcasses.	5½ Inch Shell.	Total Rounds.	Losses. Officers. Killed or Missing.	Officers. Wounded.	Soldiers. Killed or Missing.	Soldiers. Wounded.	Material. Gun.	Carriage.	Mortar.	Bed.	Date. 1854.	
...	...	...	...	...	...	...	...	4727	...	...	3	25	1Lr.	...	...	...	17 October.	1st Bombardment and Cannonade.
...	...	...	331	...	...	...	...	4832	...	...	2	7	...	4	...	...	18 ,	
34	...	...	221	...	...	...	...	3511	...	...	...	5	2	1	...	...	19 ,	
6	...	...	136	...	...	...	...	2548	...	...	1	7	1	...	...	...	20 ,	
19	...	...	290	...	...	...	...	2117	...	...	1	6	...	1	...	...	21 ,	
7	...	...	167	...	...	...	...	2955	...	...	2	8	1	3	...	...	22 ,	
...	...	...	355	...	...	...	...	2539	1	1	2	8	1	1	...	...	23* ,	
10	...	...	59	...	...	...	...	1163	...	2	2	2	...	1	...	...	24† ,	
15	...	...	22	...	...	...	...	1055	...	...	...	1	2	...	...	...	25 ,	
45	...	...	26	...	...	...	...	1159	...	...	...	...	1	1	...	...	26 ,	
30	...	...	13	...	...	...	...	896	...	...	...	4	1Lr.	3	...	...	27 ,	
17	...	...	22	...	...	...	...	863	...	...	...	...	...	3	...	...	28 ,	
12	...	...	22	...	...	...	...	642	...	...	...	6	...	1	...	...	29 ,	
...	...	...	50	...	...	...	...	955	...	...	...	...	...	...	...	...	30 ,	
...	...	...	95	...	...	...	45	670	...	...	...	...	...	...	...	...	31 ,	
195	...	...	2109	...	...	...	45	30676	1	3	13	79	10	19	...	...	Total.	
...	...	...	100	...	...	...	25	957	...	...	...	...	...	...	...	...	1 Novem.	
3	...	...	77	...	...	...	38	947	...	1	1	2	2	1	...	...	2 ,	
...	...	...	40	...	...	...	60	712	...	...	1	...	2	1	...	...	3 ,	
...	...	...	43	...	...	...	47	689	...	1	...	...	...	...	...	1	4 ,	
7	...	...	31	...	...	...	25	809	...	...	...	...	...	...	...	...	5 ,	
...	...	...	93	...	...	...	42	881	...	...	...	...	..	1	...	...	6 ,	
..	...	...	70	...	...	...	36	796	....	...	...	1	...	...	...	...	7 ,	
...	...	...	111	...	...	...	25	664	...	...	...	1	3	...	...	...	8 ,	
6	...	...	81	...	...	...	24	662	...	...	...	2	2	...	...	...	9 ,	
...	...	...	60	...	...	...	26	439	...	...	1	...	1	...	...	...	10 ,	
...	...	...	56	...	...	...	24	454	...	...	...	...	...	...	...	...	11 ,	
...	...	...	63	...	...	...	30	617	...	...	...	...	...	...	...	...	12 ,	
...	...	...	33	...	...	...	18	305	...	...	...	...	...	...	...	...	13 ,	
...	...	...	7	...	...	...	...	34	...	...	...	...	...	...	...	...	14 ,	The great Storm.
...	...	...	24	...	...	...	24	155	...	...	...	4	1	...	...	...	15 ,	
...	...	...	5	...	...	...	...	34	...	...	...	...	...	...	...	...	16 ,	
...	...	...	12	...	...	...	3	77	...	...	...	...	...	...	...	...	17 ,	
...	...	...	4	...	...	...	...	8	...	...	...	...	...	...	...	...	18 ,	
...	...	...	3	...	...	...	3	22	...	...	...	...	...	1	...	...	19 ,	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	20 ,	
...	...	...	6	...	...	...	...	18	...	...	...	...	...	...	...	...	21 ,	
...	...	...	...	...	...	...	...	18	...	...	...	...	...	...	...	...	22 ,	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	23 ,	
...	...	...	10	...	...	...	...	27	...	...	...	...	...	...	...	...	24 ,	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	25 ,	
...	...	...	...	...	...	...	20	54	...	...	...	...	...	...	...	...	26 ,	
...	...	...	5	...	...	...	10	28	...	...	...	...	1	...	...	...	27 ,	
...	...	...	3	...	...	...	2	11	...	...	...	...	...	...	...	...	28 ,	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	29 ,	
...	...	...	6	...	...	...	...	14	...	...	...	...	...	...	...	...	30 ,	
16	...	...	943	...	...	...	482	9522	...	2	3	10	12	4	...	1	Total.	

† Capt. Moubray, wounded. † Lieut. Hope, wounded.

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EXPENDITURE OF AMMUNITION,

Guns.

Date. 1854 & 1855.	68-Pounder.					32-Pounder.					24-Pounder.					10-Inch.		8-Inch.		Lancaster	9-Pr. Field.
	Round Shot.	Common Shell.	Shrapnel.	Case.	Grape.	Round Shot.	Common Shell.	Shrapnel.	Case.	Grape.	Round Shot.	Common Shell.	Shrapnel.	Case.	Grape.	Hollow Shot.	Shell.	Hollow Shot.	Shell.	Shell.	Rounds.
1 December	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
2 ,	...	...	...	...	...	...	5	...	...	...	...	...	...	...	...	...	...	...	...	...	...
3 ,	...	...	...	...	...	...	2	...	...	...	4	...	...	...	...	...	...	...	...	...	...
4 ,	...	...	...	...	...	2	13	...	..	...	...	...	...	...	...	...	...	...	...	...	...
5 ,	...	...	...	...	...	...	...	...	...	...	18	...	...	...	...	...	...	...	...	...	...
6 ,	...	...	...	...	...	...	...	...	...	...	1	...	4	...	...	...	...	...	...	...	...
7 ,	...	...	...	...	...	8	7	...	...	...	11	...	...	...	...	...	...	...	...	...	...
8 ,	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...
9 ,	...	...	...	...	...	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
10 ,	...	...	..	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
11 ,	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...
12 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
13 ,	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...
14 ,	...	...	...	...	...	...	...	...	...	...	2	...	...	...	...	...	...	...	...	...	...
15 ,	...	...	...	...	...	...	...	...	...	...	...	...	5	...	...	...	...	...	...	...	...
16 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
17 ,	...	...	...	...	...	1	...	...	...	...	33	...	1	...	...	12	...	...	...	...	...
18 ,	...	...	...	...	...	...	...	...	...	...	4	...	...	...	...	1	...	...	...	...	...
19 ,	...	...	...	...	...	...	...	...	...	...	3	...	...	...	...	...	...	...	...	...	...
20 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
21 ,	...	...	...	...	...	4	2	...	...	...	...	...	12	...	...	...	...	3	3	...	...
22 ,	...	...	...	...	...	...	...	...	...	...	...	...	4	...	...	...	...	...	...	...	...
23 ,	...	...	...	...	...	...	...	...	...	...	17	...	...	...	...	...	...	...	...	...	...
24 ,	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...
25 ,	...	...	...	...	...	...	...	...	...	...	2	...	...	...	...	...	...	...	...	...	...
26 ,	...	...	...	...	...	...	...	...	...	...	2	6	...	...	...	...	...	...	...	...	...
27 ,	...	...	...	...	...	1	...	...	...	...	12	...	...	...	...	...	...	...	1	...	...
28 ,	...	...	...	...	...	...	...	...	...	...	2	...	...	...	...	...	...	...	...	...	...
29 ,	...	...	...	...	...	...	...	...	...	...	10	...	1	...	...	...	...	...	...	...	...
30 ,	...	...	...	...	...	...	...	...	...	...	14	...	...	...	...	...	...	...	...	...	...
31 ,	...	...	...	...	...	...	...	...	...	...	6	...	...	...	...	...	...	...	...	...	...
Total, ...	...	...	...	...	...	19	30	...	...	...	143	6	18	...	...	13	...	3	4	...	...
1 January.	...	...	...	...	...	3	...	...	...	...	10	...	...	...	...	...	...	...	...	...	...
2 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
3 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
4 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
5 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
6 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
7 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
8 ,	...	...	...	...	...	3	...	1	...	...	1	...	...	...	...	...	...	...	...	...	...
9 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2	...	...	...
10 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
11 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
12 ,	...	...	...	...	...	...	...	...	...	...	2	...	2	...	...	...	...	...	...	...	...
13 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
14 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
15 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
16 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
17 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
18 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
19 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
20 ,	...	...	...	...	...	...	...	...	...	...	2	...	...	...	...	...	...	...	...	...	...
21 ,	...	...	...	...	...	...	...	...	...	...	5	...	1	...	...	...	...	...	...	...	...
22 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
23 ,	...	...	...	...	...	...	...	...	...	...	3	...	...	...	...	...	...	...	...	...	...
24 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
25 ,	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...
26 ,	...	...	...	...	...	...	...	...	...	...	1	...	1	...	...	...	...	...	...	...	...
27 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
28 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
29 ,	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...
30 ,	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...
31 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Total, ...	...	...	...	...	...	6	...	1	...	...	27	...	4	...	...	...	...	2	...	...	...

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MEN, AND MATERIAL.

24-Pounder Rockets.	Mortars. 13-Inch. Shell.	13-Inch. Carcasses.	10-Inch. Shell.	10-Inch. Carcasses.	8-Inch. Shell.	8-Inch. Carcasses.	5⅘ Inch Shell.	Total Rounds.	Losses. Officers. Killed or Missing.	Officers. Wounded.	Soldiers. Killed or Missing.	Soldiers. Wounded.	Material. Gun.	Material. Carriage.	Material. Mortar.	Material. Bed.	Date. 1854 & 1855.
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1 December
...	...	...	8	...	...	...	...	13	...	...	1	...	1	...	...	...	2 ,
...	...	...	4	...	...	...	...	10	...	...	...	...	...	...	...	...	3 ,
...	...	...	...	...	...	...	...	15	...	...	...	1	...	...	...	...	4 ,
...	...	...	5	...	...	...	...	23	...	...	...	...	...	...	...	...	5 ,
...	...	...	14	...	...	...	8	27	...	...	...	...	...	...	...	...	6 ,
...	...	...	15	...	...	...	...	41	...	...	...	...	1	...	...	...	7 ,
...	...	...	...	...	...	...	8	9	...	...	...	...	...	...	...	...	8 ,
...	...	...	...	...	...	...	...	3	...	...	...	...	...	...	...	...	9 ,
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	10 ,
...	...	...	9	...	...	...	...	10	...	...	...	...	...	...	...	...	11 ,
...	...	...	...	...	...	...	10	10	...	...	...	...	...	...	...	2	12 ,
...	...	...	...	...	...	...	2	3	...	...	...	...	...	...	...	...	13 ,
...	...	...	...	...	...	...	7	9	...	...	...	...	...	...	...	...	14 ,
...	...	...	...	...	...	...	...	5	...	...	...	...	...	...	...	...	15 ,
...	...	...	13	...	...	...	8	21	...	...	...	...	...	...	...	...	16 ,
...	...	...	...	...	...	...	1	48	...	...	...	...	...	...	...	...	17 ,
...	...	...	...	...	...	...	1	6	...	...	...	...	...	...	...	...	18 ,
...	...	...	3	...	...	...	...	6	...	...	...	...	...	...	...	...	19 ,
...	...	...	...	...	...	...	12	12	...	...	...	...	...	...	...	...	20 ,
...	...	...	3	...	...	...	...	17	...	...	...	...	...	...	...	...	21 ,
...	...	...	6	...	...	...	1	11	...	...	...	...	...	...	...	...	22 ,
...	...	...	2	...	...	...	1	20	...	...	...	...	...	...	...	...	23 ,
...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	24 ,
...	...	...	...	...	...	...	...	2	...	...	...	...	...	...	...	...	25 ,
...	...	...	2	...	...	...	...	10	...	...	...	...	...	...	...	...	26 ,
...	...	...	22	...	...	...	...	36	...	...	...	...	...	...	...	...	27 ,
...	...	...	...	...	...	...	...	2	...	...	...	...	...	...	...	...	28 ,
...	...	...	4	...	...	...	...	15	...	...	...	...	...	...	...	...	29 ,
...	...	...	2	...	...	...	...	16	...	...	...	...	...	...	...	...	30 ,
...	...	...	1	...	...	...	...	7	...	...	...	...	...	...	...	...	31 ,
...	...	...	123	...	...	...	59	408	...	...	1	1	2	...	...	2	Total.
...	...	...	...	...	...	...	...	13	...	...	...	...	...	...	...	...	1 January.
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2 ,
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	3 ,
...	...	...	...	...	...	...	4	4	...	...	...	...	...	...	...	...	4 ,
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	5 ,
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	6 ,
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	7 ,
...	...	...	2	...	...	...	...	7	...	...	...	...	...	...	...	...	8 ,
...	...	...	...	...	...	...	...	2	...	...	...	...	...	...	...	...	9 ,
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	10 ,
...	...	...	3	...	...	...	8	11	...	...	...	...	...	...	...	...	11 ,
...	...	...	...	...	...	...	...	4	...	...	...	...	...	...	...	...	12 ,
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	13 ,
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	14 ,
...	...	...	1	...	...	...	...	1	...	...	...	...	...	...	...	...	15 ,
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	16 ,
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	17 ,
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	18 ,
...	...	...	...	...	...	...	2	2	...	...	...	...	...	...	...	...	19 ,
...	...	...	...	...	...	...	...	2	...	...	...	...	...	...	...	...	20 ,
...	...	...	...	...	...	...	6	12	...	...	...	...	...	...	...	...	21 ,
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	22 ,
...	...	...	...	...	...	...	5	8	...	...	...	...	...	...	...	...	23 ,
...	...	...	...	...	...	...	17	17	...	...	...	...	...	...	...	...	24 ,
...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	25 ,
...	...	...	...	...	...	...	2	4	...	...	...	...	...	...	...	...	26 ,
...	...	...	...	...	...	...	3	3	...	...	...	...	...	...	...	...	27 ,
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	28 ,
...	...	...	...	...	...	...	3	4	...	...	...	...	...	...	...	...	29 ,
...	...	...	...	...	...	...	7	8	...	...	...	...	...	...	...	...	30 ,
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	31 ,
...	...	...	6	...	...	...	57	103	...	...	...	...	...	...	...	...	Total.

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EXPENDITURE OF AMMUNITION,

Date. 1855.	Guns. 68-Pounder. Round Shot.	Common Shell	Shrapnel.	Case.	Grape.	32-Pounder. Round Shot.	Common Shell.	Shrapnel.	Case.	Grape.	24-Pounder. Round Shot.	Common Shell	Shrapnel.	Case.	Grape.	10-Inch. Hollow Shot.	Shell.	8-Inch. Hollow Shot.	Shell.	Lancaster Shell.	9-Pr. Field. Rounds.
1 February.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
2 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
3 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
4 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
5 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
6 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
7 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
8 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
9 ,	...	...	...	...	...	...	...	...	...	...	...	...	2	...	...	...	...	...	...	...	...
10 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
11 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
12 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	2	...	...
13 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
14 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
15 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
16 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
17 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
18 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
19 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
20 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
21 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
22 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
23 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
24 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
25 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
26 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
27 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
28 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Total,	...	...	...	...	...	...	...	...	...	...	...	...	2	1	...	...	...	...	2	...	...
1 March.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
2 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
3 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
4 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
5 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
6 ,	...	...	...	...	...	53	7	...	...	...	...	...	...	...	...	...	...	...	...	...	...
7 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
8 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
9 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
10 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
11 ,	...	...	...	...	...	30	40	...	...	...	15	...	...	...	...	...	...	...	...	...	...
12 ,	...	...	...	...	...	...	...	...	...	...	37	...	8	...	...	...	...	...	...	...	...
13 ,	...	...	...	...	...	...	...	...	...	...	11	...	7	...	...	...	...	...	...	...	...
14 ,	...	43	...	...	...	...	...	...	...	...	26	...	10	...	...	...	...	...	...	...	...
15 ,	...	42	—	...	..	13	2	...	...	...	27	...	...	...	...	...	...	...	...	...	...
16 ,	...	...	...	...	...	2	...	...	...	...	5	...	3	...	...	...	...	...	...	...	...
17 ,	20	25	...	...	...	19	10	...	..	...	11	...	...	...	...	...	...	...	...	...	...
18 ,	7	39	...	...	...	...	...	...	...	...	30	...	...	...	...	...	...	...	...	...	...
19 ,	...	45	...	...	...	...	...	...	...	...	31	...	...	...	...	...	...	...	...	...	...
20 ,	...	36	...	...	...	...	...	...	...	...	27	...	...	...	...	...	...	...	...	...	...
21 ,	...	46	...	...	...	...	...	...	...	...	4	...	...	...	...	...	...	...	...	...	30
22 ,	2	58	...	...	...	...	...	...	...	...	5	...	...	...	...	...	...	...	...	...	52
23 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	43
24 ,	...	...	...	...	...	...	...	...	...	...	17	...	6	...	...	...	...	...	...	...	55
25 ,	31	30	...	...	...	...	...	...	...	...	9	...	...	...	...	...	...	...	...	...	31
26 ,	...	...	...	...	...	...	...	...	...	...	27	...	...	...	...	...	...	...	...	...	26
27 ,	...	50	...	...	...	...	...	...	...	...	7	...	...	...	...	...	...	...	...	...	6
28 ,	2	42	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	27
29 ,	...	...	...	...	...	...	...	...	...	...	9	...	...	...	...	...	...	...	...	...	...
30 ,	...	...	...	...	...	...	...	...	...	...	20	...	...	...	...	...	...	...	...	...	16
31 ,	...	25	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	30
Total,	62	481	...	...	...	117	59	...	...	...	318	...	34	...	...	...	...	...	...	...	316

Digitized by Google

MEN, AND MATERIAL.

24-Pounder Rockets.	Mortars. 13-Inch. Shell.	13-Inch. Carcasses.	10-Inch. Shell.	10-Inch. Carcasses.	8-Inch. Shell.	8-Inch. Carcasses.	5¾ Inch Shell.	Total Rounds.	Losses. Officers. Killed or Missing.	Officers. Wounded.	Soldiers. Killed or Missing.	Soldiers. Wounded.	Material. Gun.	Carriage.	Mortar.	Bed.	Date. 1855.
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1 February.
...	...	...	...	...	...	...	4	4	...	...	...	...	...	...	...	...	2 ,,
...	...	...	...	...	...	...	4	4	...	...	...	...	...	...	...	...	3 ,,
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	4 ,,
...	...	...	...	...	...	...	2	2	...	...	...	...	...	...	...	...	5 ,,
...	...	...	...	...	...	...	...	2	...	...	...	...	...	...	...	...	6 ,,
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	7 ,,
...	...	...	...	...	...	...	...	3	...	...	...	...	...	...	...	...	8 ,,
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	9 ,,
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	10 ,,
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	11 ,,
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	12 ,,
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	13 ,,
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	14 ,,
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	15 ,,
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	16 ,,
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	17 ,,
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	18 ,,
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	19 ,,
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	20 ,,
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	21 ,,
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	22 ,,
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	23 ,,
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	24 ,,
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	25 ,,
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	26 ,,
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	27 ,,
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	28 ,,
...	...	...	...	...	...	...	10	15	...	...	...	...	...	...	...	...	Total.
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1 March.
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2 ,,
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	3 ,,
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	4 ,,
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	5 ,,
...	...	...	...	...	...	...	...	60	...	...	...	1	...	...	...	...	6 ,,
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	7 ,,
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	8 ,,
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	9 ,,
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	10 ,,
...	6	...	27	...	...	...	...	118	...	...	...	...	...	...	...	...	11 ,,
...	22	...	...	...	...	...	...	67	...	...	...	...	...	...	...	...	12 ,,
...	2	...	48	...	...	...	...	68	...	...	...	...	...	...	...	...	13 ,,
...	1	...	34	...	...	...	...	114	...	...	...	...	...	...	...	...	14 ,,
...	7	...	45	...	...	...	...	136	...	...	...	2	...	...	...	...	15 ,,
...	17	...	32	...	...	...	...	59	...	...	...	...	...	...	...	...	16 ,,
...	37	...	29	...	...	...	...	151	...	...	...	...	...	...	...	...	17 ,,
...	16	...	21	...	...	...	...	113	...	...	...	...	...	...	...	1	18 ,,
...	5	...	51	...	...	...	...	132	...	...	...	...	...	...	...	...	19 ,,
...	27	...	10	...	...	...	...	100	...	...	...	...	...	...	...	...	20 ,,
...	26	...	19	...	...	...	...	125	...	...	...	...	...	...	...	...	21 ,,
...	58	...	4	...	...	...	...	179	...	...	...	...	1	...	...	...	22 ,,
...	51	...	2	...	...	...	...	96	...	...	...	...	...	...	...	...	23 ,,
...	34	...	...	...	...	...	...	112	...	...	...	1	...	...	...	...	24 ,,
...	40	...	...	...	...	...	...	141	...	...	...	...	...	...	...	...	25 ,,
...	41	...	...	...	...	...	...	94	...	...	...	...	...	...	...	...	26 ,,
...	58	...	...	...	...	...	...	121	...	...	...	1	...	...	...	...	27 ,,
...	68	...	...	...	...	...	...	139	...	...	...	...	...	...	...	...	28 ,,
...	41	...	...	...	...	...	...	50	...	...	...	...	...	...	...	...	29 ,,
...	51	...	...	...	...	...	...	87	...	...	...	...	...	1	...	...	30 ,,
...	25	...	2	...	...	...	44	126	...	...	...	...	...	...	...	...	31 ,,
...	633	...	324	...	...	...	44	2388	...	...	...	5	1	1	...	1	Total.

Digitized by Google

EXPENDITURE OF AMMUNITION,

Date. 1855.	Guns.																					
	68-Pounder.					32-Pounder.					24-Pounder.					10-Inch.		8-Inch.		Lancaster	9-Pr. Field.
	Round Shot.	Common Shell.	Shrapnel.	Case.	Grape.	Round Shot.	Common Shell.	Shrapnel.	Case.	Grape.	Round Shot.	Common Shell.	Shrapnel.	Case.	Grape.	Hollow Shot.	Shell.	Hollow Shot.	Shell.	Shell.	Rounds.
1 April.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	4	26	...	...
2 ,	2	24	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	5
3 ,	16	3	...	...	...	...	...	...	...	...	11	...	...	...	...	...	...	...	...	...	34
4 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2	22	...	16
5 ,	...	...	...	...	...	...	...	...	...	...	50	...	...	...	...	...	...	...	16	...	14
6 ,	...	...	...	...	...	...	...	...	...	...	27	...	...	...	...	...	...	6	19	...	...
7 ,	...	...	...	...	...	...	...	...	...	...	19	...	...	...	...	...	...	...	20	...	3
8 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
9 ,	...	...	...	...	...	419	...	3	...	...	788	243	...	...	...	...	...	40	95	...	...
10* ,	...	...	...	...	...	348	15	14	...	...	872	...	...	...	...	...	...	6	98	...	17
11† ,	...	80	...	...	...	485	...	...	...	...	912	150	...	...	...	...	100	60	210	...	5
12 ,	140	...	...	...	...	1231	25	52	...	...	1245	...	11	...	...	...	...	100	100	...	35
13‡ ,	144	70	...	...	...	2214	192	72	...	...	1046	...	11	...	...	...	...	34	263	...	14
14‖ ,	141	71	...	...	...	2570	33	16	...	...	1110	...	...	...	...	...	...	364	239	...	26
15 ,	210	50	...	...	...	2064	29	5	...	...	531	...	...	...	...	120	...	480	264	...	20
16 ,	...	...	...	...	...	266	...	...	...	...	998	...	...	...	...	...	...	...	249	...	7
17 ,	...	...	...	...	...	77	...	3	...	...	149	...	...	...	...	...	...	...	147	...	...
18 ,	...	...	...	...	...	80	...	...	...	...	180	...	...	...	...	...	...	...	73	...	...
19 ,	...	...	...	...	...	323	...	...	...	...	84	...	...	...	...	10	...	112	34	...	...
20 ,	90	...	...	...	...	698	...	...	...	...	100	...	...	...	...	10	...	86	...	...	...
21 ,	85	...	...	...	...	492	...	...	...	...	184	...	...	...	...	20	...	78	47	...	...
22 ,	45	...	...	...	...	301	...	...	...	...	36	...	...	...	...	...	...	13	...	...	...
23 ,	65	...	...	...	...	283	...	...	...	...	43	...	...	...	...	14	...	57	...	...	...
24 ,	40	...	...	...	...	512	...	...	...	...	96	...	...	...	...	20	...	60	...	...	...
25 ,	...	...	...	...	...	22	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
26 ,	...	...	...	...	...	32	20	...	...	...	4	...	...	...	...	...	...	...	...	...	...
27 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
28 ,	...	...	...	...	...	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
29 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
30 ,	...	...	...	...	...	11	...	...	...	...	...	...	...	...	...	...	...	...	...	...	8
Total, ...	978	298	...	...	...	12460	414	165	...	...	8485	393	22	...	...	194	160	1512	1922	...	204
1 May.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
2 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
3 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
4 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
5 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
6 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
7 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
8 ,	...	...	...	...	...	6	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
9 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	4	...	...
10 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
11 ,	...	...	...	...	...	12	6	...	...	...	...	...	...	...	...	...	...	...	...	...	...
12 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
13 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
14 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
15 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
16 ,	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
17 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
18 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
19 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	5	...	...
20 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
21 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...
22 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
23 ,	...	...	...	...	...	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
24 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
25 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	5	3	...	...
26 ,	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
27 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
28 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	8	8	...	...
29 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2	...	...	...
30 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
31 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Total, ...	..	...	...	...	...	23	6	...	...	...	...	...	...	...	...	...	...	17	20	...	...

* Lieut. SINCLAIR, wounded. † Lieut. LUCE, killed. ‡ Lieut. L'ESTRANGE, wounded.

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MEN, AND MATERIAL.

24-Pounder Rockets.	Mortars. 13-Inch. Shell.	13-Inch. Carcasses.	10-Inch. Shell.	10-Inch. Carcasses.	8-Inch. Shell.	8-Inch. Carcasses.	5⅘ Inch Shell.	Total Rounds.	Losses. Officers. Killed or Missing.	Officers. Wounded.	Soldiers. Killed or Missing.	Soldiers. Wounded.	Material. Gun.	Material. Carriage.	Material. Mortar.	Material. Bed.	Date. 1855.	
...	...	...	37	...	...	...	27	94	...	...	...	...	...	...	...	...	1 April.	
...	...	...	36	...	...	...	42	109	...	...	...	...	...	...	...	...	2 ,	
...	...	...	23	...	...	...	2	80	...	...	...	...	...	...	...	...	3 ,	
...	12	...	29	...	...	...	26	107	...	...	1	1	...	...	...	...	4 ,	
...	76	...	61	...	...	...	78	297	...	...	...	2	1	3	...	...	5 ,	
...	38	...	29	...	...	...	21	140	...	...	...	...	...	...	...	...	6 ,	
...	3	...	13	...	...	...	...	58	...	...	...	...	...	...	...	...	7 ,	
...	18	...	19	...	...	...	...	37	...	...	...	1	...	...	...	...	8 ,	
...	951	...	1089	...	...	...	...	3658	...	...	3	7	7	...	...	...	9 ,	
...	575	...	840	...	...	...	...	2785	...	1	2	7	...	1	1	...	10* ,	
...	480	...	647	...	...	...	45	3234	1	...	3	3	4	6	...	...	11† ,	
...	795	...	619	...	...	...	38	4391	...	...	1	3	1	3	1	2	12 ,	
...	644	...	357	...	...	...	...	5061	...	1	4	22	...	...	...	...	13‡ ,	
...	760	...	771	...	...	...	10	6111	1	1	4	20	3	2	...	...	14‖ ,	
...	770	...	443	...	...	...	1	4907	...	...	...	4	...	...	...	...	15 ,	
...	686	...	341	...	...	...	...	2547	...	...	2	10	2	...	...	...	16 ,	
...	217	...	170	...	...	...	24	787	...	...	...	...	...	1	...	...	17 ,	
...	229	...	156	...	...	...	24	742	...	...	...	1	1	...	...	...	18 ,	
...	194	...	75	...	...	...	61	893	...	...	1	1	...	...	...	...	19 ,	
...	194	...	209	...	...	...	36	1423	...	...	...	...	...	...	...	...	20 ,	
...	120	...	136	...	...	...	9	1171	...	...	...	...	1	...	...	...	21 ,	
...	137	...	24	...	...	...	18	574	...	...	...	...	...	1	...	...	22 ,	
...	118	...	12	...	...	...	117	709	...	...	...	2	...	...	...	...	23 ,	
...	63	...	...	...	...	...	91	882	...	...	...	...	...	...	...	...	24 ,	
...	17	...	2	...	...	...	...	41	...	...	...	...	...	...	...	...	25 ,	
...	27	...	3	...	...	...	43	129	...	...	2	...	...	...	...	...	26 ,	
...	91	...	23	...	...	...	31	145	...	...	...	...	...	...	...	...	27 ,	
...	17	...	...	...	...	...	...	19	...	...	...	...	...	...	...	...	28 ,	
...	...	...	...	...	...	...	5	5	...	...	...	...	...	...	...	...	29 ,	
...	36	...	14	...	...	...	48	117	...	...	...	...	...	...	...	...	30 ,	
...	7268	...	6180	...	...	...	797	41352	2	3	23	84	20	17	2	2	Total.	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1 May.	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2 ,	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	3 ,	
...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	4 ,	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	5 ,	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	6 ,	
...	1	...	...	...	...	...	2	3	...	...	...	2	...	...	...	...	7 ,	
...	4	...	...	...	...	...	2	12	...	...	...	...	...	...	...	...	8 ,	
...	26	...	4	...	...	...	...	34	...	...	...	...	...	...	...	...	9 ,	
...	4	...	...	...	...	...	...	4	...	...	...	...	...	...	...	...	10 ,	
...	7	...	...	...	...	...	...	25	...	...	...	...	...	...	...	...	11 ,	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	12 ,	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	13 ,	
...	3	...	...	...	...	...	...	3	...	...	...	...	...	...	...	...	14 ,	
...	3	...	1	...	...	...	...	4	...	...	...	...	...	...	...	...	15 ,	
...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	16 ,	
...	30	...	7	...	...	...	...	37	...	...	...	...	...	...	...	...	17 ,	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	18 ,	
...	24	...	...	...	...	...	7	37	...	...	...	...	...	...	...	...	19 ,	
...	19	...	...	...	...	...	...	19	...	...	...	...	...	...	...	...	20 ,	
...	14	...	...	...	...	...	...	15	...	...	...	...	...	...	...	...	21 ,	
...	16	...	...	...	...	...	...	16	...	...	...	1	...	...	...	...	22 ,	
...	17	...	2	...	...	...	...	22	...	...	...	...	...	...	...	...	23 ,	
...	9	...	10	1	...	...	...	20	...	...	...	...	...	...	...	...	24 ,	
...	44	...	5	...	...	...	8	65	...	...	...	2	...	...	...	...	25 ,	
...	10	...	2	...	...	...	...	13	...	...	...	...	...	...	...	...	26 ,	
...	2	...	...	...	...	...	...	2	...	...	...	...	...	...	...	...	27 ,	
...	7	...	5	2	...	...	...	30	...	...	...	2	...	...	...	...	28 ,	
...	13	...	8	...	...	...	...	23	...	...	...	...	...	...	...	...	29 ,	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	30 ,	
...	2	...	...	...	...	...	...	2	...	...	...	...	...	...	...	...	31 ,	
...	255	...	44	3	...	...	19	387	...	...	...	8	...	..	...	...	Total.	

2nd Bombardment.

‖ Lieut. MITCHELL, killed.

‖ Assistant-Surgeon COCKERILL, wounded.

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EXPENDITURE OF AMMUNITION,

GUNS.

Date. 1855.	68-Pounder.					32-Pounder.					24-Pounder.					10-Inch.		8-Inch.		Lancaster	8-Fr. Field.
	Round Shot.	Common Shell.	Shrapnel.	Case.	Grape.	Round Shot.	Common Shell.	Shrapnel.	Case.	Grape.	Round Shot.	Common Shell.	Shrapnel.	Case.	Grape.	Hollow Shot.	Shell.	Hollow Shot.	Shell.	Shell.	Rounds.
1 June.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
2 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
3 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
4 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
5 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
6* ,	...	...	92	...	...	1034	...	...	...	...	...	...	...	...	...	24	14	1041	575	...	...
7† ,	...	...	...	...	...	2558	20	...	...	...	...	...	...	...	...	69	171	1268	1262	...	...
8 ,	...	...	63	...	...	916	1	...	...	...	...	...	...	...	...	160	104	1971	1311	...	...
9‡ ,	...	...	197	...	...	735	...	...	...	...	...	...	...	...	...	148	65	1516	402	...	...
10 ,	...	...	...	...	...	664	27	...	...	...	...	...	...	...	...	179	65	1462	230	...	...
11 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	33	...	2	...	...	...
12 ,	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	3	...	...
13 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	6	...	...
14 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2	...	...	...
15 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2	...	...
16 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2	...	...
17 ,	767	...	24	...	...	1948	...	...	...	...	...	...	...	...	...	123	26	1371	1607	...	...
18 ,	...	...	...	...	...	295	171	...	...	...	...	...	...	...	...	99	40	865	713	...	...
19 ,	...	...	...	...	...	23	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
20 ,	...	...	...	...	...	...	2	...	...	...	...	...	...	...	...	...	...	16	...	...	...
21 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	11	...	...	...
22 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	5	5	...	...
23 ,	...	...	...	...	...	1	1	...	...	...	...	...	...	...	...	...	...	1	23	...	...
24 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	9	...	...	...
25 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	23	3	...	...
26 ,	...	...	...	...	...	2	1	...	...	...	...	...	...	...	...	...	...	27	...	...	...
27 ,	...	...	...	...	...	5	...	...	...	...	...	...	...	...	...	...	...	4	7	...	...
28 ,	...	...	...	...	...	...	5	...	...	...	...	...	...	...	...	...	...	8	8	...	...
29 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
30 ,	...	...	...	...	...	3	...	...	...	...	...	...	...	...	...	...	...	5	3	...	...
Total, ...	767	...	376	...	...	8185	228	...	...	...	...	...	...	...	...	825	485	9843	6160	...	...
1 July.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	8	8	55	1	...	...
2 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	4	6	...	...
3 ,	...	...	13	...	...	9	...	...	...	...	...	...	...	...	...	...	...	38	23	...	...
4 ,	...	...	...	...	...	2	...	...	...	...	...	...	...	...	...	1	10	33	22	...	...
5 ,	...	...	4	...	...	...	...	...	...	...	...	...	...	...	...	...	...	4	29	...	...
6§ ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	16	8	...	...
7 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2	22	...	...
8 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	56	8	...	...
9 ,	...	...	31	...	...	...	...	...	...	...	...	...	...	...	...	...	...	416	222	...	...
10 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	14	...	131	51	...	...
11 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	7	6	...	...
12 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	18	11	...	...
13 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	25	10	...	...
14 ,	...	...	...	...	...	5	...	...	...	...	...	...	...	...	...	...	...	10	13	...	...
15 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	33	...	...	...
16 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	13	9	...	...
17 ,	...	...	...	...	...	4	...	...	...	...	...	...	...	...	...	...	...	...	3	...	...
18 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
19 ,	...	...	...	...	...	12	...	...	...	...	...	...	...	...	...	...	...	2	...	...	...
20 ,	...	...	...	...	...	12	...	...	...	...	...	...	...	...	...	...	2	...	...	...	...
21 ,	...	...	...	...	...	4	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
22 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	3	...	1	...	...	...
23 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	3	104	...	...	...	...
24 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	4	17	...	...	...	...
25 ,	...	...	...	...	...	...	2	...	...	...	...	...	...	...	...	...	1	...	...	...	...
26 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
27 ,	...	...	...	...	...	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
28 ,	...	...	...	...	...	3	...	...	...	...	...	...	...	...	...	1	...	17	24	...	...
29 ,	...	...	...	...	...	13	...	...	...	...	...	...	...	...	...	...	3	...	...	...	...
30 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	6	1	...	...	...	...
31 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...						
Total, ...	...	...	48	...	...	67	2	...	...	...	...	...	...	...	...	40	146	888	467	...	...

* Capt. M. Adye, wounded. * Capt. A. Gordon, wounded. † Capt. Arbuthnot, wounded, † Lieut. Keene, wounded.

Digitized by Google

MEN, AND MATERIAL.

24-Pounder Rockets.	Mortars. 13-Inch. Shell.	13-Inch. Carcasses.	10-Inch. Shell.	10-Inch. Carcasses.	8-Inch. Shell.	8-Inch. Carcasses.	5½ Inch Shell.	Total Rounds.	Losses. Officers. Killed or Missing.	Officers. Wounded.	Soldiers. Killed or Missing.	Soldiers. Wounded.	Material. Gun.	Material. Carriage.	Material. Mortar.	Material. Bed.	Date. 1855.	
...	8	...	...	...	...	...	...	8	...	...	...	...	...	...	...	...	1 June.	
...	7	...	...	...	...	...	...	7	...	...	...	...	...	...	...	...	2 ,	
...	30	24	2	4	...	...	...	60	...	...	...	...	...	...	1	...	3 ,	
...	15	...	...	...	...	...	...	15	...	...	...	1	...	...	...	...	4 ,	
...	32	...	...	...	...	...	...	32	...	...	...	...	...	...	...	...	5 ,	
...	1451	...	808	...	...	...	...	5042	...	2	4	14	2	4	...	...	6* ,	3rd Bom.
...	2588	...	1374	...	...	...	...	9310	...	2	7	39	...	2	...	...	7† ,	
...	2193	...	1266	...	...	...	...	7985	...	...	2	8	...	1	...	...	8 ,	
...	985	...	1037	2	...	...	...	5117	...	1	2	7	1	1	1	...	9‡ ,	
...	733	...	702	22	...	165	...	4309	...	...	5	9	...	2	...	...	10 ,	
...	...	...	12	6	...	...	...	53	...	...	...	3	...	...	...	...	11 ,	
...	300	...	2	4	...	...	...	310	...	...	...	...	...	1	1	...	12 ,	
...	55	...	14	45	...	140	...	260	...	...	...	...	...	...	...	...	13 ,	
...	64	...	9	34	...	...	...	106	...	...	...	...	...	...	...	...	14 ,	
...	50	...	1	...	...	...	...	53	...	...	...	1	...	...	...	...	15 ,	
...	12	...	1	...	...	...	...	15	...	...	...	...	...	...	...	...	16 ,	
...	1780	...	873	...	954	51	...	9534	...	2	2	17	2	1	1	...	17‖ ,	4th Bom.
...	506	...	134	...	308	...	...	3131	...	...	5	16	...	...	...	...	18 ,	
...	23	...	11	6	...	...	...	63	...	...	1	...	...	...	...	...	19 ,	
...	8	...	7	...	107	7	...	147	...	...	...	1	...	...	...	...	20 ,	
...	10	...	5	21	42	10	...	102	...	...	...	1	...	...	...	...	21 ,	
...	18	...	...	...	...	2	...	28	...	...	...	...	...	...	...	...	22 ,	
...	12	...	...	...	...	...	...	38	...	...	...	...	...	...	...	...	23 ,	
...	95	...	7	...	...	...	...	111	...	...	...	1	...	...	...	...	24 ,	
...	116	...	...	...	...	...	...	142	...	...	...	...	...	...	...	...	25 ,	
...	107	...	...	...	...	...	...	137	...	...	1	...	...	...	...	...	26 ,	
...	120	...	...	...	...	...	...	136	...	...	...	...	...	...	...	...	27 ,	
...	57	...	15	...	...	...	...	93	...	...	...	...	...	...	...	...	28 ,	
...	114	...	...	...	2	...	...	116	...	...	...	...	...	...	...	...	29 ,	
...	109	...	40	...	...	...	...	160	...	...	...	...	...	...	...	...	30 ,	
...	11608	24	6380	144	1413	375	...	46623	...	7	29	118	5	12	4	...	Total.	
...	171	...	81	...	27	2	...	288	...	...	...	...	...	...	...	...	1 July.	
...	130	...	50	...	...	...	...	252	...	...	...	...	...	...	...	...	2 ,	
...	102	...	90	...	...	...	...	202	...	...	...	...	...	...	...	...	3 ,	
...	117	...	38	...	4	...	...	242	...	...	...	...	...	...	...	...	4 ,	
...	67	...	92	1	...	...	...	228	...	...	...	1	...	...	...	...	5 ,	
...	73	...	10	...	...	...	...	120	1	...	...	...	...	...	...	...	6§ ,	
...	84	...	67	...	...	...	...	175	...	...	...	...	...	...	...	...	7 ,	
...	114	...	48	...	...	...	...	186	...	...	...	...	...	...	...	...	8 ,	
...	163	...	81	...	...	...	...	308	...	...	...	...	...	...	...	...	9 ,	
...	462	...	251	...	...	...	...	1382	...	...	1	5	2	1	...	...	10 ,	
...	99	...	31	...	12	...	...	338	...	...	...	...	...	...	...	...	11 ,	
...	124	...	83	...	14	...	...	232	...	...	...	...	...	...	...	...	12 ,	
...	55	...	101	...	23	...	...	208	...	...	...	...	...	...	...	...	13 ,	
...	51	...	140	...	6	...	...	232	...	...	...	...	...	...	...	...	14 ,	
...	103	...	195	...	50	...	...	374	...	...	...	...	...	...	...	...	15 ,	
...	45	...	176	...	22	...	...	276	...	...	...	...	...	...	...	...	16 ,	
...	177	...	117	...	6	...	...	322	...	...	...	...	...	...	...	...	17 ,	
...	191	1	78	...	25	...	...	302	...	...	...	...	...	...	...	...	18 ,	
...	98	15	147	...	24	...	...	284	...	...	1	...	...	...	...	...	19 ,	
...	190	...	163	...	8	...	63	438	...	...	...	...	...	...	...	...	20 ,	
...	151	...	232	...	57	...	61	515	...	...	...	...	...	...	...	...	21 ,	
...	198	...	96	...	7	...	47	352	...	...	...	...	...	...	...	...	22 ,	
...	160	...	88	...	14	...	23	289	...	...	1	...	...	...	...	...	23 ,	
...	248	...	54	...	...	...	63	472	...	...	...	...	...	...	...	...	24 ,	
...	213	...	95	...	52	...	19	400	...	...	...	...	...	...	...	...	25 ,	
...	217	...	213	...	36	...	77	516	...	...	1	3	...	...	...	...	26 ,	
...	211	...	195	...	...	...	75	481	...	...	...	1	...	...	...	...	27 ,	
...	206	...	248	...	...	...	77	534	...	...	...	...	...	...	...	...	28 ,	
...	149	...	208	...	28	...	97	527	...	...	1	...	...	...	...	...	29 ,	
...	205	...	270	...	50	...	60	601	...	...	...	...	...	...	...	...	30 ,	
...	124	...	190	...	2	...	8	331	...	...	...	...	...	...	...	...	31 ,	
...	4398	16	3926	1	467	2	670	11438	1	...	5	10	2	1	...	...	Total.	

‡ Lieut. CONOLLY, wounded. ‖ Lieut. TILLARD, wounded. ‖ Lieut. SCOTT, wounded. § Capt. A. GORDON, killed.

Digitized by Google

EXPENDITURE OF AMMUNITION,

Guns.

Date. 1855.	63-Pounder.					32-Pounder.					24-Pounder.					10-Inch.		8-Inch.		Lancaster	9-Pr. Field.
	Round Shot.	Common Shell.	Shrapnel.	Case.	Grape.	Round Shot.	Common Shell.	Shrapnel.	Case.	Grape.	Round Shot.	Common Shell.	Shrapnel.	Case.	Grape.	Hollow Shot.	Shell.	Hollow Shot.	Shell.	Shell.	Rounds.
1 August.	1	...	...	...	...	4	3	...	...	...	...	...	...	...	...	...	...	2	4	...	...
2 ,	...	...	...	...	...	29	...	...	...	...	...	...	...	...	...	...	...	4	...	...	...
3 ,	1	...	...	...	...	61	18	...	...	...	...	...	...	...	...	...	12	21	17	...	...
4 ,	7	...	...	...	...	29	5	...	...	...	...	...	...	...	...	2	6	23	29	...	...
5 ,	...	...	...	...	...	67	...	...	...	...	...	...	...	...	...	...	4	...	1	...	...
6 ,	2	...	...	...	...	6	1	...	...	...	...	...	...	...	...	3	...	2	15	...	...
7 ,	...	...	...	...	...	2	...	...	...	...	...	...	...	...	...	...	1	3	10	...	...
8 ,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	7	...	4	...	...
9 ,	1	2	...	...	...	3	5	...	...	...	...	...	...	...	...	9	7	6	3	...	...
10 ,	...	...	...	...	...	14	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
11 ,	1	...	...	...	...	5	...	...	...	...	...	...	...	...	...	...	...	37	36	...	...
12 ,	...	...	...	...	...	23	...	...	...	...	...	...	...	...	...	...	1	4	17	...	...
13 ,	...	...	...	...	...	2	...	...	...	...	...	...	...	...	...	...	...	23	25	...	...
14 ,	...	...	...	...	...	10	1	...	...	...	...	...	...	...	...	8	3	21	57	...	...
15 ,	...	...	...	...	...	16	9	...	...	...	...	...	...	...	...	...	...	15	14	...	...
16 ,	...	...	...	...	...	...	91	...	...	...	...	...	...	...	...	15	15	...	60	...	...
17* ,	...	...	...	...	...	3469	150	...	...	...	...	...	...	...	...	125	228	563	330	...	...
18 ,	211	...	86	...	...	1161	169	424	4	7	...	...	...	...	...	505	339	2543	1231	...	...
19 ,	...	40	...	...	...	1038	298	...	...	...	...	...	...	...	...	13	14	1523	809	8	...
20† ,	22	...	...	...	...	627	74	10	...	...	...	...	...	...	...	55	15	261	67	14	...
21 ,	2	6	...	...	...	120	55	...	...	...	...	...	...	...	...	2	5	18	145	...	...
22 ,	21	3	...	...	...	24	33	...	...	...	...	...	...	...	...	25	...	25	41	...	...
23‡ ,	21	...	...	...	...	45	19	...	...	...	...	...	...	...	...	12	...	35	38	...	...
24 ,	22	...	...	...	...	27	20	...	...	...	...	...	...	...	...	33	...	...	14	...	...
25 ,	22	...	...	...	...	47	82	...	...	...	...	...	...	...	...	2	2	65	94	...	...
26‖ ,	67	...	10	...	...	109	49	...	...	...	...	...	...	...	...	10	22	49	86	...	...
27 ,	49	...	...	...	...	79	74	...	...	...	...	...	...	...	...	...	8	182	9	...	...
28 ,	13	...	...	...	...	55	138	10	...	...	...	...	...	...	...	...	1	34	60	...	...
29 ,	...	12	...	...	...	156	109	...	...	...	...	...	...	...	...	20	9	234	75	...	...
30 ,	33	...	...	...	...	114	70	...	...	...	...	...	...	...	...	...	1	63	57	...	...
31 ,	22	...	...	...	...	52	51	...	...	...	...	...	...	...	...	...	...	13	18	...	...
Total,	518	63	96	...	...	7394	1524	444	4	7	...	...	...	...	...	840	700	5769	3396	22	...
1§ Sept.	19	...	...	...	...	120	56	...	...	...	...	...	...	...	...	...	...	27	38	...	...
2¶ ,	19	...	...	...	...	171	64	...	...	...	...	...	...	...	...	...	...	120	27	...	...
3 ,	15	...	...	...	...	115	74	...	...	...	...	...	...	...	...	...	...	134	191	...	...
4 ,	19	...	1	...	...	157	51	...	...	...	...	...	...	...	...	...	...	77	36	...	...
5 ,	3	...	...	...	...	1317	184	...	...	...	...	...	...	...	...	...	...	...	125	...	...
6†† ,	465	...	...	...	...	3447	110	...	...	...	...	...	...	...	...	54	...	636	649	...	...
7 ,	412	...	...	...	...	665	7	42	...	...	...	...	...	...	...	105	...	264	84	...	...
8‡‡ ,	...	...	2	...	...	2605	166	9	...	...	...	...	...	...	...	20	...	531	74	...	...
Total,	952	...	3	...	...	8597	712	51	...	...	...	...	...	...	...	179	...	1789	1224	...	...

* Capt. Oldfield, killed. † Capt. P. Dickson, wounded. ‡ Lieut. de Winton, wounded.

†† Capt. Snow, killed. ‡‡ Capt. Fitzroy, killed. ‡‡ D.-A.-Com. Hayter, killed. ‡‡ Lieut. Tyler, wounded.

Digitized by Google

MEN, AND MATERIAL.

24-Pounder Rockets.	Mortars. 13-Inch. Shell.	13-Inch. Carcasses.	10-Inch. Shell.	10-Inch. Carcasses.	8-Inch. Shell.	8-Inch. Carcasses.	5⅘ Inch Shell.	Total Rounds.	Losses. Officers. Killed or Missing.	Officers. Wounded.	Soldiers Killed or Missing.	Soldiers Wounded.	Material. Gun.	Material. Carriage.	Material. Mortar.	Material. Bed.	Date. 1855.	
...	35	...	214	...	16	...	19	288	...	...	...	...	...	...	...	...	1 August.	
...	4	...	195	...	5	...	...	237	...	...	...	...	...	...	...	...	2 ,	
...	9	...	173	...	9	...	16	267	...	...	...	...	...	...	...	...	3 ,	
...	5	...	168	...	...	...	27	230	...	...	...	1	...	...	...	...	4 ,	
...	...	...	119	...	...	...	37	224	...	...	...	1	...	...	...	...	5 ,	
...	214	...	83	...	...	...	146	495	...	...	...	2	...	...	...	...	6 ,	
...	17	...	101	...	...	...	43	182	...	...	...	1	...	...	...	...	7 ,	
...	3	...	77	...	...	...	47	139	...	...	...	...	1	...	1	...	8 ,	
...	14	..	43	...	...	...	...	93	...	...	...	1	...	...	...	...	9 ,	
...	102	...	76	...	...	...	33	225	...	...	...	...	...	...	...	...	10 ,	
...	197	...	152	...	...	...	13	441	...	...	1	5	...	...	...	...	11 ,	
...	508	...	50	...	...	...	...	601	...	...	...	...	...	...	...	...	12 ,	
...	209	...	54	1	...	...	...	316	...	...	...	1	...	...	...	...	13 ,	
...	49	...	89	...	...	...	28	269	...	...	...	4	...	...	...	...	14 ,	
...	47	...	59	...	2	...	47	209	...	...	...	2	...	...	...	...	15 ,	
...	327	...	247	...	...	...	86	881	...	...	...	6	3	...	...	...	16 ,	
...	2216	...	2316	...	...	...	529	9917	1	...	5	23	6	7	...	...	17* ,	5th Bombard.
54	1385	...	1629	12	...	...	128	9879	...	...	...	11	1	...	...	...	18 ,	
11	1081	...	889	...	...	...	97	5729	...	...	...	6	2	1	...	1	19 ,	
31	229	...	517	...	...	3	91	2036	...	1	...	5	1	...	1	...	20† ,	
9	118	...	754	...	...	...	126	1389	...	...	1	5	1	...	1	...	21 ,	
10	6	...	331	...	68	...	13	600	...	...	...	3	...	...	...	...	22 ,	
...	52	...	315	...	40	...	78	655	...	1	2	4	...	...	...	...	23‡ ,	
...	42	...	504	...	52	...	118	832	...	...	...	...	...	...	...	...	24 ,	
...	72	...	353	...	71	...	93	913	...	...	...	1	...	1	...	...	25 ,	
3	127	...	760	...	146	...	...	1438	...	1	...	3	...	...	...	...	26‖ ,	
3	190	...	285	...	129	4	20	1032	...	...	...	...	1	...	...	...	27 ,	
2	147	...	206	...	159	20	10	855	...	...	...	1	1	...	...	...	28 ,	
23	267	...	393	...	...	...	...	1298	...	...	...	3	...	...	...	...	29 ,	
...	54	...	546	...	41	...	...	979	...	...	...	1	...	...	...	...	30 ,	
...	71	...	470	...	170	...	...	867	...	...	...	2	...	...	...	...	31 ,	
146	7803	...	12042	13	908	27	1841	43557	1	3	9	92	17	9	3	1	Total.	
...	123	...	402	...	73	...	23	881	...	1	...	1	...	1	...	...	1§ Sept.	
...	92	...	546	...	46	...	9	1094	...	1	...	1	...	1	...	...	2** ,	
10	127	...	461	...	...	...	39	1166	...	...	...	2	1	...	...	...	3 ,	
15	100	...	146	...	...	...	10	612	...	...	1	2	...	...	...	...	4 ,	
...	1015	...	667	...	218	...	59	3588	...	...	2	4	...	...	...	...	5 ,	6th Bom.
...	2268	...	1842	...	240	...	16	9727	1	...	1	8	1	...	...	...	6†† ,	
...	1690	...	1695	...	275	...	100	5339	...	...	1	7	...	...	...	...	7 ,	
...	1494	...	1001	...	137	...	39	6078	2	2	5	32	...	...	...	...	8‡‡ ,	
25	6909	...	6760	...	989	...	295	28485	3	4	10	57	2	2	...	...	Total.	

‖ Capt. Arbuthnot, wounded. § Lieut. Price, wounded. ** Lieut. Roberts, wounded.

‡‡ Lieut. Champion, wounded. ‡‡ Fall of Sevastopol.

Digitized by Google

EXPENDITURE OF PROJECTILES AND LOSSES IN MEN

Date.	Guns.																					
	68-Pounder.					32-Pounder.					24-Pounder.					10-Inch.		8-Inch.		Lancaster	9-Pr. Field
	Round Shot.	Shell.	Shrapnel.	Case.	Grape.	Round Shot.	Shell.	Shrapnel.	Case.	Grape.	Round Shot.	Shell.	Shrapnel.	Case.	Grape.	Hollow Shot.	Shell.	Hollow Shot.	Shell.	Shell.	Rounds.
Oct., 1854.	214	43	223	12	...	361	...	...	...	...	18371	22	103	82	...	...	...	4153	4541	202	...
Nov., ,,	19	6	...	...	...	1082	56	2	...	...	4831	4	71	...	...	...	...	1767	243	...	...
Dec., ,,	...	...	...	...	...	19	30	...	...	...	143	6	18	...	...	13	...	3	4	...	...
Jan., 1855.	...	...	...	...	...	6	...	1	...	...	27	...	4	...	...	...	...	2	...	...	...
Feb., ,,	...	...	...	...	...	...	...	...	...	...	...	...	2	1	...	...	...	...	2	...	...
March, ,,	62	81	...	...	...	117	59	...	...	...	318	...	34	...	...	...	...	...	...	...	316
April, ,,	978	298	...	...	...	12490	314	165	...	...	8485	393	22	...	...	194	160	1512	1922	...	204
May, ,,	...	...	...	...	...	23	6	...	...	...	...	...	...	...	...	...	...	17	20	...	...
June, ,,	767	...	376	...	...	8185	228	...	...	...	...	...	...	...	...	835	485	9643	6160	...	...
July, ,,	...	...	48	...	...	67	2	...	...	...	...	...	...	...	...	40	146	888	467	...	...
Aug., ,,	518	63	96	...	...	7394	1524	444	4	7	...	...	...	...	...	840	700	5769	3396	22	...
Sept., ,,	952	...	3	...	...	8597	712	51	...	...	...	...	...	...	...	179	...	1789	1224	...	...
Total, ...	3510	891	746	12	...	38311	2931	663	4	7	32175	425	254	83	...	2101	1491	25543	17979	224	520

No. of Rounds expended by the Naval Brigade,

Total No. of Rounds expended

TABLE SHEWING THE ARMAMENT AT THE COMMENCEMENT OF EACH BOMBARDMENT.

	Mortars.				Guns.							Total.	Pieces of Ordnance.	
	13-In.	10-In.	8-In.	5½-In.	Lancaster	68-Pr.	32-Pr.	24-Pr.	9-Pr.	10-In.	8-In.		Served by Artillerymen.	Served by Naval Brig.
1st Bombardment.	...	10	...	...	4	5	7	30	...	...	16	72	53	19
2nd ,,	20	16	...	...	...	6	42	20	...	4	15	123	74	49
3rd ,,	26	17	...	...	...	8	49	...	...	8	46	154	98	56
4th ,,	30	17	8	...	...	8	49	...	...	8	46	166	115	51
5th ,,	33	24	7	20	1	4	53	...	...	8	46	196	141	55
6th ,,	34	27	10	20	2	6	61	...	3	7	37	207	158	49

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AND MATERIAL DURING THE SIEGE OF SEVASTOPOL.

24-Pounder Rockets.	Mortars. 13-Inch. Shell.	13-Inch. Carcasses.	10-Inch. Shell.	10-Inch. Carcasses.	8-Inch. Shell.	8-Inch. Carcasses.	5½ Inch Shell.	Total Rounds.	Losses. Officers. Killed or Missing.	Officers. Wounded.	Soldiers. Killed or Missing.	Soldiers. Wounded.	Material. Guns.	Material. Carriages.	Material. Mortars.	Material. Beds.	Date.
195	...	...	2109	...	...	...	45	30676	1	3	13	79	19	19	...	...	Oct., 1854.
16	...	...	943	...	...	...	482	9522	...	2	3	10	12	4	...	1	Nov., ,
...	...	...	113	...	...	...	59	408	...	...	1	1	2	...	...	2	Dec., ,
...	...	...	6	...	...	..	57	103	...	...	...	...	...	...	...	...	Jan., 1855.
...	...	...	...	...	...	...	10	15	...	...	...	...	...	...	...	...	Feb., ,
...	633	...	324	...	...	...	44	2388	...	...	...	5	1	1	...	1	March, ,
...	7268	...	6189	...	...	...	797	41352	2	3	23	84	20	17	2	2	April, ,
...	255	..	44	3	...	...	19	387	...	...	..	8	...	...	...	...	May, ,
...	11608	24	6389	144	1413	375	..	46823	...	7	29	118	5	12	4	...	June, ,
...	4688	16	3926	1	487	2	670	11438	1	...	5	10	2	1	...	...	July, ,
146	7803	...	12462	13	908	27	1841	43557	1	3	9	92	17	9	3	1	Aug., ,
25	6909	...	6760	...	989	...	295	28485	3	4	10	57	2	2	...	...	Sept., ,
382	39174	40	38827	161	3777	404	4319	214954	8	22	93	464	71	65	9	7	Total.
and not Reported.								38088									
during the Siege.								253042									

TABLE SHEWING THE No. OF PIECES OF ORDNANCE PLACED IN THE BATTERIES DURING THE SIEGE, AND THOSE THAT HAVE BECOME UNSERVICEABLE.

	Mortars. 13-In.	10-In.	8-In.	5½-In.	Guns. Lancaster	68-Pr.	32-Pr.	24-Pr.	9-Pr.	10-In.	8-In.
Total No. in use	35	35	11	20	7	8	105	57	3	10	76
Unserviceable from use	4	5	...	1	3	3	65	29	...	1	36
Destroyed by the Enemy	1	2	...	...	...	3	32	25	1	2	25
Remaining Serviceable at the end of the Siege	30	28	11	19	4	2	8	3	2	7	15

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REPORT

UPON THE

ORGANIZATION OF THE ARMY OF THE EAST, BY MARSHAL VAILLANT, MINISTER OF WAR.

TRANSLATED BY LIEUT. R. E. CANE, R.A.

Letter of H. M. the EMPEROR to His Excellency the Minister of War.

Compiègne, October 22nd, 1856.

My dear Marshal,

The most useful services are not always the most brilliant. The able and indefatigable Minister who is employed day and night in his cabinet in organizing 600,000 men, and in assuring to an army of 200,000 every thing necessary for their subsistence, for fighting and for conquering in a land without resources 800 leagues from home; this Minister, I say, deserves credit at least equal to that due to the General who triumphs on the field itself. The country, also, should be equally grateful to him who prepares for victory by the seasonable combination of its element, and to him who actually gains it by skilfully adopted measures on the spot.

It is for this reason, my dear Marshal, that in directing the insertion in the *Moniteur* of the remarkable report you have addressed to me, I have wished to render the public the judges of services, of which I alone have as yet known the real importance.

Receive, my dear Marshal, the assurance of my sincere friendship.

NAPOLEON.

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Report addressed to the Emperor.

Paris, September 8th, 1856.

Sire,

The war, which has just terminated in so glorious a manner for the arms of your Majesty and your august Allies, has been carried on under conditions altogether exceptional. To transport to the East, and to maintain there at the complete establishment, armies, which, under the flags of France, England, and Sardinia, amounted to 200,000 fighting men, and to supply them with everything requisite, it was necessary either to create or to develope vast resources.

I have hoped that your Majesty may read with interest a report exhibiting the entire of those resources as far as concerned the French army, the effective strength of which was increased, in the course of the year 1855, to 150,000 men, and that, perhaps, you would deign to recognize the zeal displayed by the Ministry of War in obedience to the powerful impulse of the Emperor, in the accomplishment of so laborious a task.

This report consists of three distinct parts:—

The first treats of the *Personnel* of the army itself, giving the number of troops embarked for the East, and of those which returned either to France or to Algiers, and indicating the precautionary measures taken on their departure, return, &c.

The second part under the title of *Matériel*, exhibits the resources of the Artillery at different periods of the war; the importance and extent of the supplies of every species of stores sent to the Crimea; those sent by the Engineer department; the provisions made by the military administration, properly so-called, for the subsistence of the troops, for fuel, clothing, forage, encampment, harness; the resources and supplies for the hospital service, as well for the moveable hospitals as the light ambulances. This division of the subject also includes the organization of religious service in the hospitals and the army itself; it gives a general view of the means placed at the disposition of the military train, and treats of some services—which I cannot think of calling *accessories*, although they appear only as secondary, so to speak—for instance, the military chest, the post-offices, the printing establishment, and the telegraph which appeared for the first time as a department regularly attached to an army.

The third part exhibits the naval resources employed to transport from the harbours of France and Algiers to Gallipoli, Constantinople, Varna, Eupatoria, and the providential bay of Kamiesch, the Eastern

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army and its immense stores, as well as to ensure their return. Formidable as had been the muster of the Imperial Navy, it was, nevertheless, necessary to hire a considerable number of merchant vessels; and the Ministry of War has transported, by its own peculiar resources, a considerable part of the *personnel* of the army, as well as almost the entire of the horses and *matériel*.

The numbers given in the following tables need no commentary: they prove sufficiently the greatness of the enterprize, and the efforts made to realize the projects of your Majesty, and to provide, in obedience to your orders, not only for the wants, but even for the comforts of your soldiers of the Eastern army.

FIRST PART, *PERSONNEL.*

Movements of Troops—Departure.

	Men.	*Horses.*
No of men and horses embarked in France,	257,324	35,777
„ „ in Algiers,	47,980	5,967
„ „ in Corsica,	1,998	...
„ „ in Italy, (Army of Occupation.)	1,963	230
Total of Troops sent out,	309,268	41,974

Losses experienced by the Army.

		Men.
The number of deaths at the date of 30th March, 1856, amounted to		62,492
From that time to the end of the evacuation, (period of cholera and typhus) there died		4,564
Total of registered deaths,		67,056
Men missing, and prisoners of war, during the entire siege, amounted to	2,573	
Exchanges of prisoners, now nearly completed, have restored to France 792 soldiers of all ranks,	792	
		1,781
Soldiers who perished in the wreck of the *Semillante*,		392
Grand total of the loss of the army,		69,229

Return.

			Men.
Soldiers returned separately, convalescent, or on leave,			65,069
Corps recalled from the army before the signing of Peace.	Regiment of *Tirailleurs Algériens*,	1,824	20,390
	„ *Gendarmerie de la Garde*,	1,166	
	Division of the Imperial Guard,	12,000	
	20th, 39th, 50th, 97th Regiments of the Line, and 3rd Battalion of the *Chasseurs à pied*,	5,400	

The effective strength of the army of the East on March 30th, 1856, was 146,240 men, as follows:—

In the Crimea,	120,476		
In Turkey:—Under arms, 15,316		146,240	
„ In hospital, 10,448	25,764		
Number of deaths occurring during the evacuation, as before-mentioned,		4,564	
There have consequently returned from the East, since the conclusion of peace,			141,676
Grand total of men returned,			227,135

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Abstract of the above.

	Men.
Sent to the East, ...	309,268
Losses of the army, ...	69,229
	240,039
Returned from the East to France and Algiers, . .	227,135
Difference, ...	12,904

In this last number are included, on one hand, all individuals who set out with the army, or in its train, without being attached to any regiment or corps; and, on the other hand, officers and soldiers who embarked for the East more than once. The latter, were soldiers who came back to France convalescent or on leave, and returned to the army after their restoration to health, or expiration of leave; they appear at least twice in the total of men embarked.

The greater part of the horses have been transported from the Crimea into Turkey, and given up to the Ottoman Government. About 9000 have been brought to France and Algiers.

Observations.

To suffice for the wants of the war, as well as for the assemblage of troops to operate on different points of the interior of the empire, (Paris, Lyons, Metz, Luneville, Camp of Boulogne, St. Omer, and the South), as well as to maintain the effective strength of the army of Africa, many new corps were created, and establishments augmented:—

9th March, 1854, Creation, for the Army of the East, of a Regiment of *Tirailleurs Algériens.*

20th April, „ Creation of a 6th squadron in 53 Cavalry Regiments.

1st May, „ Re-establishment of the Imperial Guard, which is now composed as follows:—

- 1 Regiment of *Gendarmerie* with 2 Battalions, formed with the 2 Battalions of *Gendarmerie d'elite.*
- 2 Regiments of Grenadiers of 3 Battalions, (new creation.)
- 2 Regiments of *Voltigeurs,* of 3 Battalions, (new creation.)
- 1 Battalion of *Chasseurs à pied,* of 10 Companies, (new creation.)
- 1 Regiment of *Cuirassiers,* of 6 Squadrons, (new creation.)
- 1 Regiment of *Guides,* of 6 Squadrons, formed with the Regiment of *Guides* already in existence.
- 1 Regiment of Horse Artillery, of 5 Batteries, and a depôt establishment, (new creation.)
- 1 Company of Engineers, (new creation.)

26th May, „ Augmentation of the establishment of the staff of clothing and encampment.

Augmentation of the staff of officers of administration in the *bureaux de l'intendance militaire.*

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24th June, 1854, Creation, for the service of the army in the East, of a corps of Light Cavalry, under the name of *Spahis d'Orient.*

21st July, „ Augmentation of the establishment of Surgeons and Apothecaries. (By decree of August 4th, 1855, the establishment of Military Surgeons was increased to 460 *sons-aides.*)

12th August, „ Creation of a Squadron of *Gendarmerie* of the Guard, (formed with the brigades appropriated for the superintendence of Crown Forests, and of the routes frequented by the Emperor.)

14th August, „ Augmentation of the personal establishment of military subsistance. (This is still further increased by the decree of June 30, 1855.)

21st Sept., „ Augmentation of the establishment of officers of administration of military hospitals.

15th Nov., „ Reconstitution of the 6 Companies of the 3rd Battalion in the 100 Regiments of Infantry of the Line.

23rd Dec., „ Creation of a Regiment of Zouaves of the Imperial Guard, of 2 Battalions.

9th Jan., 1855, Creation of a 2nd Battalion of *Tirailleurs Indigénes* in each of the three provinces of Algiers.

17th Jan., „ Creation of a 2nd Foreign Legion, composed of 2 Regiments of 2 Battalions, and of 1 Battalion of *Tirailleurs* of 10 Companies.

17th Feb., „ Creation, in the Imperial Guard, of:—
A 3rd Battalion in the Regiment of *Gendarmerie.*
A 4th Battalion in each of the Regiments of Grenadiers and *Voltigeurs.*
A 6th Battery in the Regiment of Horse Artillery.
A 2nd Company of Engineers.
A Squadron of Field Train.

7th March, „ Augmentation of the *Etat-Major general,* and of the Imperial Corps of *Etat-Major.*

16th „ „ Augmentation of the corps de *l'intendance militaire.*

24th „ „ Creation of a 4th Battalion in the 100 Regiments of Infantry. (This measure has been also applied to 2 Regiments of the 1st Foreign Legion.)

2nd April, „ Creation of 2 Regiments of Infantry, (of 4 Battalions) which received the numbers 101 and 102.

27th June „ Creation of a 7th and 8th Squadron in each of the 4 Regiments of *Chasseurs d'Afrique.*

14th August, „ Creation of 2 Battalions of *Chasseurs à pied,* which received the numbers 21 and 22.

7th Novem. „ Disbandment of the Regiment of *Tirailleurs Algériens,* of 6 provincial Battalions of *Tirailleurs Indigénes,* and creation of 3 Regiments of *Tirailleurs Algeriens* of 3 Battalions. (1 Regiment for each province.)

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20th Dec., 1855, Re-organization of the Imperial Guard, and creation of the following corps:—

Infantry.. { 3rd Regiment of Grenadiers, of 4 Batts.
3rd Regiment of *Voltigeurs*, „
4th Regiment of *Voltigeurs*, „

Cavalry... { 2nd Regiment of *Cuirassiers*, 6 Squadrons
Regiment of Dragoons, „
Regiment of *Chasseurs*, „
Regiment of *Lanciers*, „

At the same time the following measures were adopted to recruit the army:—

5th Jan., 22nd Jan., and 22nd Feb., 1854. Decrees, calling into activity the young men still disposable from the contingents of the conscriptions of 1852, 1851, 1850, and 1849.

10th April, 1854, Law, increasing this contingent from 80,000 to 140,000 men, to be summoned in 1854, on the class of 1853.

1st May, „ Decree, calling into activity 80,000 men on the contingent of the class of 1852.

14th Sept., „ Decree, calling into activity the remaining 60,000 men of the contingent of 1853.

9th Novem., „ Imperial decision, which retains under their standards the men of the class of 1847.

24th Jan., 1855, Law, which fixes at 140,000 men the contingent to be called out in 1855 on the class of 1854.

5th March, „ Decree, which calls into activity the 140,000 men of the class of 1854. (They were set *en route* between the 25th and the 30th of March.)

11th July, „ Law, which fixes at 140,000 men the contingent to be called in 1856 on the class of 1855.

19th Nov., 1856, Imperial decision, which retains under their standards the men of the class of 1848.

It was in the 9th military division, at Toulon and Marseilles, that nearly all the drafts of troops and *matériel* were perfected. General de Rostolan, commanding the division, was charged with the direction of these operations. He acquitted himself of this task with a zeal and ability to which too much praise cannot be given.

The telegraph transmitted constantly from Paris to Marseilles the orders of the Emperor, and the instructions of the Minister of War, the execution of which, as far as regarded transports, was hastened by the railways and steam boats. Thanks to these means, thanks above all to the devotion of every moment on the part of the military functionaries, the French Army, at more than 800 leagues from the northern country, has constantly received its reinforcements in due time, and has never had to wait either for food or clothing.

The troops destined for the army from all points of the empire, whether by march or by the railroads, arrived at Toulon and Marseilles only in proportion to the means of maritime transport already in these ports;

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until then, they were disposed in echelon in the 8th and 9th military divisions, and, as much as possible, on the lines of railway which should convey them to the port of embarkation at the precise moment of departure.

A commission presided over by a General Officer, and composed of Officers of all arms, took care that the arrangements of the troops on board were as good as possible, and fixed the number of men and horses to be received in each ship, so as to preserve the health of the passengers from the danger always consequent upon crowding. While carefully observing on this subject the limits prescribed by experience, they were, nevertheless, enabled to combine the departures, so that detachments of the same corps should not be divided among different vessels; an arrangement most conducive to discipline, since it retained the men of each company under the immediate orders of their own officers.

Corps and detachments received instructions, previous to their sailing, relative to the hygienic measures to be observed during the voyage, and to the dispositions to be made on their first arrival in the East.

The merchant vessels were obliged to have surgeons and medical appliances the same as those of government ships. The Military Intendant of the 9th division has frequently placed on board those vessels the military and civil surgeons required.

From the commencement of the winter of 1854, convalescents or men on leave from the East, began to arrive in considerable numbers at Marseilles; they were placed in a "*Depôt of Disembarkation*," where they received for some days the attention which their state of health required. They were then sent either to the depôt of their respective corps, or wherever they intended to enjoy their leave of absence.

Foreseeing the disease which the hardships of a war could not fail to develop in so numerous an army, the hospital resources of the military divisions, bordering on the Mediterranean, had been increased in a remarkable degree.* The sick sent to these provisional hospitals received the necessary care and treatment there, notwithstanding the difficulties occasioned in the medical service of our southern cities by the two choleraic epidemics of 1854 and 1855. In proportion, as the patients were fit to bear the journey, they were sent to the military hospitals of the interior.

At the time when the progress of negociations rendered the return of the troops to France likely, typhus fever was raging in the Crimea and at Constantinople. The Emperor, having given his attention to this complication, prescribed the dispositions to be made to save the country from an invasion of this new epidemic. By his orders the Ministers of War, and of the Department of Agriculture, Commerce, and Public Works, with the advice of the Council of Health, and the Committee of *Hygiène*, adopted measures in concert, which were immediately put in execution.

* A temporary hospital had been created at Avignon; the Barracks *de la Corderie*, at Marseilles; that of the *Jeu de Paume*, at Toulon; the Citadel of Montpelier, and the Chateau d'O, the property of the Bishop of Montpellier, (which that prelate generously offered for the purpose) were converted into hospitals. Besides these the military hospital of Cette, and the sheds of the Lazaretto of Frioul, at Marseilles, had been fitted with 1000 beds. In all 3000 beds.

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Independently of the precautions prescribed to the army still in the Crimea, such as the complete isolation of detachments for some days before embarkation, it was resolved that the troops should be placed in quarantine on an isolated point of the sea coast at home. For this purpose, three large camps were established, viz.:—

At the Isle of Porquerolles, for 12,000 men. At the Isle of St. Marguerite, for 6,000 men. And on the flat beach of Cavalaire, near Saint Tropez, for 12,000 men, and a considerable number of horses. This last point was more particularly employed for mounted troops, so as to avoid the necessity for re-embarking the horses at the expiration of the quarantine, an operation always difficult.

In a few days, wells were dug, watering places for the horses constructed, and camp stores brought to the spot, so that when the first troops entered France after the signature of peace, the three camps of observation were ready to receive, at once, 30,000 men, and 2000 horses.

Three superior officers of known merit had been invested, on their return from the East, with the command of those camps.

At the same time, hutting had been constructed, capable of receiving under the most favorable conditions, 500 sick at St. Marguerite, as many at Porquerolles, and 250 at Cavalaire.

M. Maillot, Military Surgeon-Inspector, was sent from Paris to direct the arrangements of the medical staff; and M. Mélier, Inspector-General of Public Health, was charged by the Minister of Agriculture, Commerce, and Public Works, with the superintendance of the sanitary precautions to be observed. Doctor Blache, Director of the service of Health at Marseilles, much facilitated the execution of this task.

Similar dispositions were adopted in the ports of Algiers, where the corps permanently attached to the army of Africa, were to disembark.

The first arrivals (in April, 1856,) were made under the conditions just indicated, and all the troops of the Division of Failly remained some days at the camp of Porquerolles, as well as the discharged conscripts of the class of 1849.

However, the cessation of the epidemic in the Crimea, and the excellent sanitary state of the troops disembarked, soon allowed of some relaxation in admitting ships laden with troops to free communication with shore. Until the end of the evacuation, however, they were obliged to undergo an inspection at Porquerolles, where the healthy state of the troops was certified: they were then permitted to disembark at Marseilles. After the arrival of the Division of Failly, only two ships were retained; one, laden with Infantry, disembarked them at Porquerolles, the other, with Cavalry, brought them to Cavalaire.

As soon as the embarkations of troops in the Crimea became frequent, by the chances of sailing, simultaneous arrivals necessarily happened; and as the troops quitted Marseilles only in limited number, to avoid blocking up the lines of march, which, besides were liable to be rendered impracticable by inundations, it might have been necessary, in case of several ships arriving together, to have had recourse to billeting the troops on the inhabitant. But as exaggerated fears of the

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state of the soldiers' health had been conceived, it was necessary to dissipate them; and re-assure the townspeople, for which purpose General de Rostolan established in a few days, in the approaches to Marseilles, six camps capable of lodging 12,000 men, and 2000 horses. The wisdom of this foresight was not slow in showing itself, and by several arrivals, 10,000 men, and 1200 horses, were found at one time in these camps. It is thus that more than 100,000 men, and 5000 horses had, during three months, passed through Marseilles, without a single man or horse being quartered on the inhabitants; besides which, the sanitary state of the troops assembled in the camps was constantly satisfactory.

The return home of the army was completed by the evacuation of the hospitals of Constantinople; the hospital frigates of the Imperial Navy made the first passages with the sick, who were deposited at St. Marquerite and Porquerolles; the marine hospital of St. Maudrier received the remainder.

The temporary camps and hospitals have been now for some time evacuated. The sick remaining at St. Maudrier every day being discharged, so that the hospital will be very shortly again placed at the entire disposition of the Minister of Marine.

A delay of six months, counting from April 27th, the date of the ratification of the treaty of peace, had been fixed for the complete evacuation of the territories occupied by the Allies. This operation commenced on April 11th; and on the 5th of July, less than three months after, notwithstanding all the delays and embarrassment caused by the sickness which at that time existed in our army, Marshal Pélissier, who had presided in person over the embarkation of all the soldiers, was the last man who quitted the Crimea. The last portion of troops left Constantinople on the 18th of August, under the command of General Pariset, Military Commandant.

SECOND PART, *MATERIEL.*

ARTILLERY.

Siege Train.

			No.
Pieces of Ordnance..	*Canons*.....	of 24	72
		of 16	44
		of 12, Field	20
	Canons-obusiers	of 12	24
		of 12, Light	12
	Obusiers.....	of 22, Garrison	20
		of 22, Siege	55
		of 16, Field	20
		of 12, Mountain	12
	Mortiers.....	of 32	102
		of 32, Coast	18
		of 27	118
		of 22	103
		of 15	24
	Total of pieces of Ordnance		644

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Matériel placed at the disposal of the Siege Train by the Navy.

			No.
Pieces of Ordnances with Carriages and Appointments.	*Canons*	of 50	8
		of 30, No. 1	338
		of 30, No. 2	18
		of 30, Rifled	6
	Canons-obusiers of 30		9
	Obusiers	of 80, No. 1	71
		of 80, No. 2	17
	Different Calibres rendered unserviceable in firing		138
		Total	665
	Turkish Ordnance of all Calibres, with Carriages		140
Carriages	Siege, for Guns.	of 14	170
		of 16	64
	Garrison, for the Iron Howitzers of 22		25
	Field	of 12	54
		of 12, Light	36
	Mountain, for the Howitzers of 12		16
	Mortars	of 32	129
		of 32, Coast	18
		of 27	147
		of 22	131
		of 15	31
		Total Carriages	821
Different Vehicles	Platform Wagons		141
	Sling Carts		18
	Park Wagons		250
	Trench Wagons		220
	Ammunition Wagons		80
	Battery Store Carts		25
	Field Forges		45
		Total Vehicles	779
Projectiles	Round Shot	of 24	195,600
		of 16	87,920
	Howitzer Shells	of 22	166,000
		of 15	78,000
		of 12	41,000
	Bomb Shells	of 32	154,350
		of 32, Coast	13,850
		of 27	202,000
		of 22	142,500
	Hand Grenades		75,000
	Case Shot	of 24	1,600
		of 16	1,500
		Total Projectiles	1,159,320
Powder and made-up Ammunition.	Ball Cartridge for *Canons* of 12		20,240
	Rounds of Shell and Ball for the Howitzer of 16		20,240
	Shell and Ball Cartridge for the *Canons-obusier*		10,000
	Shell Cartridges for Mountain Howitzers		4,000
	Detonating Tubes		2,019,000
	Gun Powder in Barrels, (Kilogrammes)		2,474,000

Field Artillery.

Ordnance	*Canons-obusier* of 12	174
	Light do.	66
	Mountain Howitzers	6
	Total Ordnance	246

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			No.
Carriages & Vehicles	Light Carriages of 12		320
	Mountain Carriages		7
	Ammunition Wagons	Guns	480
		Infantry	196
	Store Carts		80
	Field Forges		80
	Total Carriages and Vehicles		1,163
Ammunition	Rounds for	*Canons-obusier*	45,760
		Mountain Howitzers	336
	Infantry Cartridges	Spherical Ball	2,527,900
		Oblong Ball	1,503,360
Carriages & Wagons	Light Carriages of 12		173
	Carriages for Mountain Howitzers		27
	Ammunition Wagons	for *Canons-obusier* of 12	618
		for Infantry Cartridges	310
	Park Wagons		61
	Store Carts		62
	Field Forges		28
	Mountain do.		16
	Total Carriages and Wagons		1,525
Ammunition*	Rounds for	*Canons-obusier*	219,996
		Mountain Howitzers	3,264
	Ball Cartridges for Infantry.	Spherical	61,606,868
		Oblong	
		Grooved, for the Guard	
		Nessler's	

To sum up, the Artillery *Matériel* assigned to the army of the East consisted of:—

1676 Guns of all Calibres.
2083 Carriages.
2710 Wagons.
2,128,000 Projectiles.
4,000,000 Kilogrammes of Powder.

Observations.

As soon as the expedition to the Crimea was decided on, a siege train of 60 guns (which had been concentrated at Toulon in expectation of the occurrence of war) was embarked and hurried to the East; it was with this train that we presented ourselves before Sevastopol.

The energy of the defence, the great number of guns in battery in the town, and the incomplete investment, (which gave a peculiar character to the siege, by permitting the enemy to recruit their supplies continually), soon compelled us to recognize the insufficiency of the means of attack at our disposal, and made it necessary to increase the siege train beyond all former calculations; with this object three supplementary trains were concentrated in succession at Marseilles and Toulon, and despatched to the Crimea; the 1st of 58 guns; the 2nd of 46; and the 3rd of 150. All those guns had from 1500 to 2000 rounds supplied to each.

The School of Pyrotechny, which had been employed for several months, by the Emperor's orders, in preparing war rockets of large ca-

* This ammunition, added to that carried by the wagons which were in the line, gave a supply of 1,107 rounds for each field, and 600 for each mountain gun. The supply of ammunition for Infantry was 547 cartridges for each man, exclusive of 60 carried by each soldier when embarking.

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libre, having ranges of from 5000 to 7000 métres, had already obtained very remarkable results. It was directed to expedite these preparations still further, and succeeded in completing and sending in to the siege train, 7000 to 8000 rockets.

The Commander-in-Chief of the Army, on his part, drew from the Arsenal of Constantinople 140 guns, some projectiles, and a considerable quantity of powder. He required at the same time from the fleet, for the armament of batteries, guns of large calibre; the number of pieces thus borrowed and placed at the disposal of the siege train soon amounted to 605, of which 238 were in battery during the last days of the siege. In addition to these guns, the fleet also furnished, for the requirements of the siege, such supplies and powder as could be dispensed with, without detriment to the naval service.

Afterwards, the defence being still prolonged, the Emperor ordered out 400 additional mortars, each supplied with 1000 rounds, in order to keep up a continual bombardment on the place, and to cover our attacks by rendering the Russian works untenable. The employment of such formidable measures promised speedy and decisive results; we have only to consider what effect would have been produced by 400 mortars, each supplied with 1000 rounds, capable of throwing, during twenty days and nights, more than 830 shells an hour, or about fourteen in a minute. Only a portion of these mortars, however, were placed in position, the town having been taken before the entire number arrived.

The organization of these different equipages, their concentration at Marseilles, and embarkation, met with numerous difficulties, which the resources accumulated in various parts of the empire, and the activity displayed in the Arsenals, enabled us to surmount. The workshops where the charges and fuzes of hollow projectiles, and the ammunition for our batteries were prepared, were established in places situated close to the railways, and worked incessantly.

The consumption of powder becoming enormous, the factories extended in an unusual degree the means of supplying it, and delivered in 1854 as many as 1,600,000 kilogrammes of service powder, which, in 1855, was increased to 3,250,000 kilogrammes, without interfering with the manufacture of sporting or blasting powders.

The transport of this immense equipment, weighing more than 50,000,000 kilogrammes, would have been utterly impossible a few years back; but the impossibility disappeared with the net-work of railways which connect Marseilles with the principal cities in the empire, and nothing delayed or interfered with the regularity of the embarkation. Besides, such was the care employed in those vast operations, that 3,000,000 killogrammes of powder, 70,000,000 ball cartridges, 270,000 cartridges for field guns, 7,000 to 8,000 war rockets ready charged, and an immense supply of various fireworks and combustible stores, arrived at their destination without our having to deplore the slightest accident.

The Artillery, seconded by six companies of the Regiment of Marine Artillery, by the sailors serving on shore, and working parties from the Infantry, constructed, armed, and served during the siege 118 batteries,

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on ground full of obstacles, and under the incessant fire of the place; at the same time they had in charge the armament and supply of the redoubts of the camp, and the lines of Kamiesch. These batteries required for their construction 800,000 sandbags, and 50,000 gabions. On the day of the assault, their armament consisted of 620 guns; they had fired more than 1,100,000 cannon shots, and consumed more than 3,000,000 killogrammes of powder.

Notwithstanding the amount of this consumption, to which history affords no parallel, the park of Artillery, at the time of the capture of Sevastopol, was still supplied with from 800 to 900 rounds per gun, without reckoning all the stores which the French ports were every day dispatching. Only forty pieces were rendered unserviceable. The resources of the Artillery would have been unimpaired for a much longer period.

The *matériel* brought back to France might be estimated at 50,000,000 kilogrammes, of which 38,000,000 were French, and 12,000,000 Russian.

ENGINEER STORES.

Various Tools and Necessaries.

	No.	*Weight.*
Digging Tools,	72,000	165,000 kilos
Quarrying Tools,	7,400	22,000 „
Wood Cutting Tools,	6,300	12,500 „
Mining Tools,	1,800	15,200 „
Hooks, Forks, and Shovels, for Sapping,	200	600 „
Sappers' Equipments,	12	230 „
Wheel Barrows,	800	18,200 „
Hand Barrows,	1700	20,000 „
Sand Bags,	920,000	230,000 „
Palisades,	8000	525,000 „
Chevaux de Frise,	80	15,000 „
Handles for Tools,	80,000	35,000 „
Skilled Workmen's Tools,	16,900	16,000 „
		1,075,830 „

Machines and Engines.

	No.	*Weight.*
Norias,	8	4,000 kilos
Pile-Driver (complete)	1	1,670 „
Wooden Ventilators for Mines,	5	250 „
Machines for Countermines,	3	900 „
Hand Mills,	5	150 „
Rammers,	1	50 „
Capstans	4	360 „
Various Cordages,	...	7,250 „
Various Ladders,	250	6,250 „
Fire Engines,	10	2,000 „

Wheeled Carriages and Duplicates.

	No.	*Weight.*
Various Carriages,	87	69,860 kilos
Various Chests,	210	12,600 „
Wheels, Axletrees, and other articles in duplicate,	325	4,450 „

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Stores and articles in constant use.

		Weight.
Various woods for siege works, and construction of temporary hospitals, huts, furnaces, magazines for stores and provisions,	*Cubic Mill.* 16,980	7,971,600 kilos
Iron,		10,870 „
Steel,		1,550 „
Sheet Iron,		1,830 „
Bags, Nails, and Spikes,		54,000 „
Pitch and Tar,		223,000 „
Candles,		4,200 „
Coals,		76,000 „
Blasting Powder,		90,400 „
Cloths for closing in and covering huts, (of which 4,100 mètres were tarred,)	*Sq. Mill.* 21,000	10,000 „
Instruments for Lifting,	400	250 „

Hutting.

	No.	*Weight.*
Huts for Officers and Soldiers,	2,900	4,047,000 kilos
Stable Huts,	210	400,000 „
Cast Metal Stoves,	2,800	84,000 „
	Total,	14,159,529 „

or about 14,000 tons.

Approximate weight of stores brought back to France after the campaigns 2,400,000 kilos, or 2,400 tons.

Observations.

The rolling stock, the large tools, and the sapping and mining instruments, have been furnished for the greater part by the Engineer Arsenals of Metz and Algiers; the remainder by private contract. The embarkation of these stores, (at least five times more considerable than should be required for the siege of a large place under ordinary conditions,) was commenced in the month of March, 1854, the last portions were sent out in August, 1855.

The supplies of planks, balks, iron, copper, sheet iron, &c., were purchased at Lyons, Toulon, Marseilles, Constantinople, and Trieste. These materials were employed not only for the siege works proper, but also for the construction of temporary hospitals before the place, and for magazines of food and ammunition.

Of the 920,000 sandbags sent out, 300,000 were drawn from the Imperial Magazines; the remainder were purchased at Paris, Lyons, Metz, Toulon, Marseilles, and Constantinople.

As soon as it became evident that the army should winter under the walls of Sevastopol, the Emperor gave directions that proper shelter should be sent to the East. Hutting for the men, and sheds for the horses, were immediately ordered in France and England. 1050 huts, capable of sheltering 30,000 men, were made up at Toulon and Marseilles in January, 1855, and the embarkation commenced in the following month. 1850 huts, capable of containing 45,000 soldiers, were ordered in England early in December, 1854, and sent from Southampton in the course of the following month; each hut was provided with a stove.

Temporary stables for about 10,000 horses were ordered at Paris, and embarked at Marseilles in January, 1855.

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In addition to the above, a supply of 50,000 pine beams, 20,000 balks, 100,000 planks, and 9000 bolts, were purchased at Marseilles, and sent out in 1855, for the establishment of the *baraques-chauffoirs.*

The Engineer service has executed, in this remarkable siege, 80 leagues of trenches, made use of 80,000 gabions, 60,000 fascines, and nearly a million sandbags. On the mountain crests which protected the right of our attack, defensive works were constructed, extending over more than 8000 mètres; and on the left, a continuous entrenchment of about the same length, almost in a straight line, called the "Lines of Kamiesch"; which, having both its extremities resting on the sea, protected the Bays of Kazatch and Kamiesch, and assured us the possession of a vast depôt where the entire resources of the army could be stored in safety. These lines were formed by a thick parapet, having in front, a ditch hollowed in the rock, and flanked by eight strong redoubts, armed with guns of large calibre.

The immense difficulty of making the approaches distinguished the siege of Sevastopol from all former sieges; it was necessary to form passages through the rock, by blasting, for almost the whole distance; and this, before a place which was garrisoned by a complete army, constantly recruited and re-victualled. We had also to overcome the obstacles presented by a subterranean defence ably planned, forming an immense net-work of more than 6000 mètres of galleries, hollowed in the rock at different depths, of which the lowest was 16 mètres below the surface.

PROVISIONS, FUEL, FORAGE.

Food.

Biscuit,	12,792,300 kilos.	=	25,584·60 tons.
Flour,	22,106,000 „	=	22,436·57 „
Dry Vegetables,	193,000 „	=	196·86 „
Compressed Vegetables,	341,900 „	=	341·90 „
Rice,	3,586,800 „	=	3,658·53 „
Salt,	79,180 „	=	93·37 „
Sugar,	2,763,100 „	=	5,058·28 „
Coffee,	2,149,600 „	=	2,436·21 „
Bacon,	5,242,100 „	=	8,733·83 „
Salt Beef,	518,200 „	=	863·32 „
Preserved Beef,	3,053,700 „	=	3,197·22 „
Hogs Lard,	50,000 „	=	60 „
Live Stock,	10,000 head.	=	35,000 „
Wine,	116,567 hectolit.	=	12,838 „
Rum and Brandy,	13,766 „	=	1,520 „
Total,			122,018·69 „

Fuel.

Wood,	1,944,900 kilos.	=	9,722 tons.
Coal,	15,772,300 „	=	15,772·30 „

Forage.

Hay,	77,403,400 kilos.	=	229,944·60 tons.
Barley and Oats,	83,700,000 „	=	119,571·43 „
			497,029·02 „
Portable articles, sent separately (about)			1,500 „
Total,			498,529·02 „

or, in round numbers, 500,000 tons. The quantity of food not consumed, and brought back to France, may be estimated at 50,000 tons.

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Observations.

Biscuits:—Were obtained from the regular military factories of Paris, Rouen, Havre, Brest, Bordeaux, Bayonne, Marseilles, Toulon, Montpellier, Perpignan, Algiers, and Oran, and purchased in England and in France from the firm Packham. 260,000 chests were required to contain them.

Flour:—Was sent from Marseilles, Toulon, Montpellier, Perpignan, Bordeaux, Algiers, and Oran.

Compressed Vegetables:—Manufactured by the firm Chollet, and sent entirely from Paris.

Rice:—Sent out in grain for the most part. It was purchased in London, at Bordeaux, and especially at Havre.

Coffee:—Supplied from the same places at the last.

Sugar:—With the exception of some consignments made at Bordeaux and Marseilles, the entire was sent from Havre as white sugar and in loaves.

Salt Provisions:—Mostly purchased in England, the remainder handed over by the Department of Marine.

Preserved Beef in Boxes:—With the exception of small quantities prepared in France by M. de Lignac, (compressed meat) and by M. Appert *(bœuf avec bouillon)*, almost the entire was made up in England. In the quantity quoted of preserved meat is included 404,000 kils. of powdered meat, or nearly 600,000 rations.

Live Stock:—4000 oxen from Trieste, 1500 from Algeria, 4500 from Caramania.

Wines:—Those for the hospitals were obtained from Bordeaux and Perpignan: those for the consumption of the troops from Var and Herault.

Brandy and Rum:—Considering the dearness and doubtful quality of brandy; rum, purchased at London and Marseilles, was supplied in preference.

Coals:—Obtained from England.

Wood:—Embarked as ballast, without cost.

Hay:—Was sent out from Nantes, Marseilles, Montpellier, Perpignan, Algiers, Mostaganem, Bône, Philippeville; and, abroad, from Antwerp, Genoa, Leghorn, Naples, Messina, and Trieste.

Barley and Oats:—Have been procured from Havre, Marseilles, and the ports of Algeria—abroad, from England, Spain, Morocco, Italy, Egypt, and Syria.

Matériel—Sacks:—100,000 sacks were sent out, either specially, or containing the above-mentioned provisions.

Ovens:—150 ovens, 60 of which were of sheet iron, portable.

Tarpaulins:—1700 pieces, representing a superficies of 204,000 sq. métres.

Presses for Hay:—137 of different systems. These machines were sent out for the purpose of compressing hay bought in Turkey.

1800 voyages, of vessels completely laden, were requisite for transport-

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ing to the East these provisions and other articles; the cargoes were taken in as follows:—

460 in France.
566 in Algeria.
4 in Spain.
77 in England.
5 in Belgium.
600 in Italy.
88 in Egypt and Syria.

Total, 1800

CLOTHING, CAMP STORES, HARNESS.

Clothing and Equipment.

	No.
Flannel Belts,	654,882
Bags for small Tents,	347,319
Camp Rugs,	371,787
Cotton Shirts,	351,529
Leather Gaiters, (pairs)	42,527
Cloth Gaiters, (pairs)	163,449
Grey Cloth Trowsers,	9,000
Pairs of Shoes,	328,209
Boots with Spurs, (pairs)	32,396
Drawers,	132,336
Cooking Blouses,	200
Stable Jackets,	25,010
Cook's Trowsers,	200
Helmets of Chasseurs d'Afrique,	717
Helmet Covers,	3,000
Carbine Slings,	525
Small Tent Poles,	183,265
Shako or Cap Peaks,	2,000
Buttons of various Regiments,	20,620
Cotton Cravats,	200,000

Special Articles.

Sabots, (pairs)	238,597
Woollen Socks, (pairs)	189,162
Great Coats, with Collar and Hood,	251,399
Woollen Stockings, (pairs)	220,000
Woollen Gloves, (pairs)	215,000
Chachias,	253,576
Sheepskin Spatterdashes,	90,000
Bulgarian Spatterdashes,	163,739
Sheepskin Coats,	15,000

Camp Stores.

Quoins,	16,448
Lance Heads,	60
Pins,	15,512
Poles for Council Tents,	68
Poles for Officers' Marquees or Troop Tents,	30,952
Cross Pieces for Council Tents,	21
„ for Tents to hold 16 men,	9,189
„ for Officers' Tents,	1,500
„ for Conical Tent for 20 men,	6,500
Shelves with Clothes Pegs,	71,209
Shelves without Clothes Pegs,	18
Tent Pegs, large and small,	567,971
Camp Stools,	3,428
Tables,	24
Curtains,	4
Driving Mallets,	23,316
Wood for Companies' Arm Stands,	640
Wood for Picquets' Arm Stands,	30

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	No.
Cloth Covers for Companies' Arm Stands,	500
Cloth Covers for Picquets' Arm Stands,	14
Large Cans,	40,973
Small Tin Cans with Straps,	289,714
Mess Tins,	43,193
Camp Kettles,	46,981
Canteen Covers,	1,019
Mess Tin Covers,	1,061
Camp Kettle Covers,	1,019
Belts for Canteen and Camp Kettles,	1,812
Belts for Mess Tins,	692
Reaping Hooks,	16,400
Scythes,	1,499
Hatchets,	17,236
Shovels,	15,748
Picks,	16,721
Bill-hooks,	8,341
Ropes for Picketing Horses, (mètres)	1,412

Harness.

Horse-shoe Nails,	6,193,400
Horse-shoes,	817,216
Wallets trimmed with Leather,	16,222
Shackles,	7,567
Ropes for do.	310
Snaffles with Curbs,	2,039
Light Cavalry Saddles, new pattern,	646
Light Cavalry Saddles, old pattern,	1,004
Bridle Bits,	900
Parade Head Pieces.	779
Double Snaffles,	368

Observations.

The events of the war had placed the Eastern Army in a country almost without resources of its own, and under a peculiar climate; it was necessary to send from France every thing required for its clothing and shelter, and even the nails for shoeing horses. The severity of the climate on the *plateaux* of the Chersonese made it necessary to send out not only the regulation clothing and camp necessaries, but in addition, a complete supply of winter garments, which gave to each soldier an additional kitt composed of:—

A Capote of Woollen Cloth, with Collar and Hood.
Bulgarian Gaiters of Cloth.
Shoes, with Woollen Socks.
Gloves, Stockings and *Chachias* of Wool.

Men on guard, and those on extraordinary services, had, in addition, a Sheepskin Coat, and Spatterdashes of the same. These garments, sent out in 1854, and the early part of 1855, required, like other clothes, to be for the most part renewed when preparing for the exigencies of the winter of 1855-56.

The camp materials in store at the commencement of the war were not sufficient for more than the requirement of an army 70,000 to 80,000 men: it then became necessary to set about the preparation of an additional supply in all haste, and to take advantage of the resources of

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private industry to meet the occasion. All these objects were safely transported, considering their immense bulk.

The number of tents, with their appurtenances, sent to the Crimea, was sufficient to encamp 280,000 men, without reckoning those for officers. The tents sent out, at first, had two poles, and were in the form of the roof of a house; but experience of the Crimean climate, and particularly the hurricane of Nov. 14th, 1854, compelled us to acknowledge that the conical tent with a single pole, used in Turkey, offered more resistance to the severity of the climate; the latter form was accordingly adopted for the tents sent out in 1855. Hempen cloth was not exclusively used in tentmaking; cotton was also employed, being more easily obtained, cheaper, and of less weight.

The scythes and reaping-hooks sent out, enabled the army to gather in the crop of forage found at first landing in the Dobrudscha, and afterwards in the Chersonese.

A large portion of the camp materials, and of the additional clothing was not employed, and has been returned into store in France and Algiers from the East.

The entire quantity of above-mentioned stores might be estimated at 12,000 tons. The special magazines attached to corps during the entire campaign are not comprised in this valuation, their total weight was about 7,300 tons. The total weight of articles returned from the East to France and Algiers was about 8,000 tons.

HOSPITAL SERVICE.

Moveable Hospitals.

	Sent from France.	Purchased in the East.		Total.
Small Iron Bedsteads,	12,000	„	(A)	27,000 beds.
Small Wooden Bedsteads,	„	15,000		
Woollen Coverlets,	32,000	7,500		39,500
Cotton Coverlets,	„	3,500		3,500
Wool for Mattrasses and Bolsters,	„	325,000 kils.		or 30,000 mattrasses.
Complete store for Hospitals, each containing 500 sick,	23	7	(B)	30
Complete supply of Medicines and Appliances for Hospitals, each containing 500 sick,	30	„		30
Chapel Furniture for Military Hospitals,	14	„	(C)	14

Ambulances.

Stores of the Light Ambulances, African pattern, for 12,000 men each,	2	„		2
Ambulance Wagons, in the proportion of 5 to each division of Infantry,	110	„	(D)	110
Regimental Ambulance Chests,	150	„		150
Ambulance Sacks, (large and small) in pairs,	35	„		35
Surgical Instrument Cases of various kinds,	106	„		106
Amputating and Trephineing Cases, contained in the Ambulance Chests,	150	„		150
Amputating Cases contained in the Wagons,	220	„		220
Instrument Cases in the Military Hospitals,	70	„		70

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Dressing Appliances.

	Sent from France.	Purchased in the East.	Total.
Large Linen for Dressing,	57,000 kil.	„	57,000 kil.
Small do. do.	76,000 „	„	76,000 „
Rolled Bandages,	32,000 „	„	32,000 „
Lint,	49,000 „	„	49,000 „
Assorted Linen for Dressing, contained in the Hospitals, Wagons, &c.,	80,000 „	„	80,000 „
Trusses for Rupture,	5,000 „	„	5,000 „

Nourishing Food for Medical uses.

Concentrated Milk,	8,000 kil.	„	(E) 8,000 kil.
Concentrated Essence of Soup,	1,000 „	„	(E) 1,000 „
Essence of Beef,	2,800 „	„	2,800 „
Granulated Gluten,	3,000 „	„	3,000 „
Conserves *Chollet julienne.* for Soldiers,	51,000 „	„	(E) 51,000 „
Conserves *Chollet julienne.* for Officers,	1,600 „	„	1,600 „
Various Preserved Vegetables,	25,000 „	„	(E) 25,000 „

Observations.

(A.) The entire of those supplies, completed by purchases on the spot, enabled us to maintain in the city of Constantinople, as regular a medical service as that in the hospitals of the interior of France.

The 27,000 beds sent out during the first month of the war constituted a *matériel* larger than the entire establishment of beds in the permanent military hospitals in France, where there are only 19,000 beds, thus told off:—

For the sick,	16,500 beds.
For infirm soldiers,	2,500 „
Total,	19,000 „

The Administration provided for the concentration of these stores, first by immediate drafts on the reserve magazines, afterwards by orders given to private industry, and executed with great promptitude.

(B.) The detail of the articles attached to those hospitals for 500 sick is indicated in the order of 1st April, 1831; it comprises, for each hospital, a weight of 12,000 kilogrammes, not including the iron and wooden beds, which weighed 360,000 killogrammes for the 30 hospitals established in the East.

(C.) By direction of the Emperor, religious service was regularly organized, and the soldiers were never left without spiritual assistance. The chaplains have exhibited the greatest devotion, and, with the admirable daughters of St. Vincent de Paul, have maintained a good moral condition among our sick and wounded in the hospitals and ambulances. The religious service for the army was directed by the Roman Catholic clergy. The central consistories of the Reformed Church, and of the Jewish persuasion, sent out ministers and rabbis to their co-religionists. The Roman Catholic service of the 14 hospitals of Constantinople was entrusted to a congregation of Lazarists, who have a college in that city, and who exercise a lively influence throughout the East. A consequence to this measure was the installation in our hospitals of the sisters of St. Vincent de Paul, of whom the Lazarists are the superiors.

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(D.) Each ambulance wagon held 2000 dressings, so that the 110 held a supply of 220,000 dressings, which could be replaced in proportion to the consumption, by supplies sent from Constantinople.

(E.) The experiments of the concentrated milk, (Lignac's process) of concentrated essence of soup, obtained from England, and of preserved vegetables, (process of Chollet and Masson) were completely successful. These products will henceforth be regularly included among hospital necessaries.

The total weight of hospital stores sent out to the East was about 6,430 tons, the weight returned to France and Algiers about the third of that quantity.

MILITARY TRAIN.

	No.	*Weight in Kil.*
Wagons of 1200 rations,	775	1,388,150
Wagons of 1600 rations,	143	122,551
Ambulance Wagons,	118	116,820
Store Carts, (without raised sides)	259	212,121
Store Carts, (with do.)	218	180,940
Forges, old pattern,	22	12,100
Forges, new pattern,	48	44,640
Draught Harness, with Head Furniture complete. Near Leader,	1,127	148,676
Off Leader,	1,148	
Near Wheeler,	1,236	
Off Wheeler,	1,285	
Driving Saddles, (complete)	1,811	214,080
Under Officers' and Mounted Men's Saddles, (complete)	1,732	
Under Adjutants' Saddles, (complete)	25	
Mules' Pack Saddles,	2,971	89,130
Horse Cloths,	16,611	29,900
Portable Forges,	21	1,995
Pairs of *Cacolets*,	2,760	27,600
Pairs of Litters,	849	36,507
Spare stores of all kinds, as grease boxes, tool chests, iron-bound wheels, poles iron-shod and plain, bridles, head-stalls, ropes, &c., &c.	„	1,500,000
Rough Material, Wood, Iron, &c.,	„	1,200,000
Marseillaise Carts with Harness,	300	200,000
Maltese do. do.,	400	
Carts, called *bouhoure*, with Harness,	100	
* Total Kilos.		5,525,210

Observations.

Notwithstanding its large number, (11,000 men, and 8000 horses or mules) the military train attached to the Eastern Army would have been insufficient for the complete administration of the department, if several provisional companies, strictly speaking not belonging to the service of the train, had not been attached to it as auxiliaries. Some of these companies were raised in the East, others in France.

The auxiliary equipage consisted of:—

400 Maltese vehicles obtained at Malta by the energy of the French Consul.

* This total represents 7,956 tonnage. About ¼ of these stores became unserviceable and have been sold; but many of the carriages, &c., constructed in Turkey, were sent to Algiers, so that the total might be estimated at 7000 tons.

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300 Marseillaise carts sent from France.

100 vehicles called *Bouhoure*, of a pattern approved by the Emperor.

1600 vehicles called *arabas* and *tekis*, either purchased in Turkey, or built by the workmen attached to the military train reserve at Constantinople.

The number of these auxiliary companies, which were created successively, and in proportion as they were required, was, at the end of the campaign, 19, being an effective strength of 2,728 native drivers, 11,346 animals, (horses, mules, oxen, and buffaloes,) and 2,425 vehicles of all sorts. These resources contributed in the highest degree to the effective management of the transport service.

The stores and harness of the military train sent to the East was about 7,956 tons. This large quantity was not actually required for the different services of the army, but a prudent foresight directed the establishment of a large reserve near the seat of war, so as to be ready on the moment, to supply any wants which might appear. Such was the motive for the formation of a reserve military train at Constantinople, in the beginning of the campaign. The extent of this reserve may be inferred from what it consisted of at the end of the war, viz.:—296 wagons, 119 store carts, 31 forges, 166 sets of harness, &c., for horses, 714 saddles, shabracks, &c., 398 pack saddles for mules, 9,155 horse cloths, 398 pairs of *cacolets*, 578 pairs of litters.

This establishment, the direction of which was intrusted, first to a Captain, and afterwards to a Major on the staff of the siege train, continued to render the most important services during the entire war. Not only had it charge of the immense repairs required for the wheeled vehicles, but it was enabled, by its prsence on the spot, to contribute to the prompt settlement of accounts in kind and money.

CIVIL DEPARTMENT—JUSTICE—ADMINISTRATION OF THE TERRITORY OCCUPIED BY THE ARMY.

One of the first cares of the administration, from the formation of the army, had been to provide for the civil condition of the soldiers, for the interest of their families, and as well in their regiments and in hospital, as on the field of battle. At the same time Provosts and Courts Martial were established in each division, for the maintenance of order and discipline. The statistics of the military judicial department prove that, at all times, there was need of but very rare employment of the means of repression placed by the law in the hands of the superior authorities.

Interpreters, commissioned by the Minister of War, maintained the necessary relations between the people of different languages engaged in the war.

In the earlier days of the occupation of Kamiesch, a municipal council, and a *conseil de prud-hommes* were organized. A Service of police and of health was soon established, and the numbers of French, as well as foreigners, who followed the army, found established in the city a constant and effectual personal protection.

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SERVICE OF THE TREASURY AND POST-OFFICE.

The staff of the Military Treasury was also charged with the Postal Service; this double duty was so perfectly organized that soldiers of all ranks received their pay and allowances as regularly as if they had been in garrison at home; and they were able to maintain almost daily communication with their families.

This staff, placed under the orders of a Paymaster-General, and composed of 6 chief paymasters, 8 special, and 75 adjuncts and subordinates, constantly satisfied all requirements, as well of the corps and divisions near Sevastopol, as of the most remote stations temporarily occupied by our troops. It was supplied with 12 carts or wagons, 104 draught and saddle horses, and 20 bât mules, to be employed as circumstances might demand, as well as with soldiers to act as drivers from the Military Train.

The service of the Military Treasury included, as in former campaigns, the following means of supply:—1st, direct supplies of funds; 2nd, cashing drafts in the place itself. This latter method has given important results, and such has been the favour with which the treasury notes were received in the East, that it was necessary to create *coupures* of 20,000 and 10,000 francs. The drafts reached 12 millions each month.

The payments made in the East from April, 1854, on the credits opened by the Minister of War, reached on July 1st, 1856, the sum of 285,646,160 fr., 45 cen.; of which 275,457,340 fr., 64 c., were on the orders of the Intendance Militaire; 1,914,340 fr., 16 c., on those of the Generals-in-Chief of Artillery, and 8,274,554 fr., 65 c., on those of the Engineer Department.

The expenses of the war have always been verified, liquidated, paid, and finally audited by receipt and expenditure, within the times fixed for the expenses on the peace footing, an arrangement advantageous in many points of view, and the more remarkable, as in no former war had a like result been attained.

TELEGRAPHIC SERVICE.

From the commencement of the war, a necessity was felt for the establishment of such communication between head-quarters and the different detached corps, as might insure the rapid transmission of orders, and effect simultaneous movements. With this object a Staff of Telegraphic Administration, composed of 2 Inspectors, 5 Directors, 4 Electric Telegraph Station-men, and 47 Station-men for the common Telegraph, was attached to the expedition.

Furnished with 16 Portable Telegraphs, capable of being put up and taken asunder easily and quickly, the staff was so distributed as to put the Commander-in-Chief in immediate communication with the different portions of his army.

During the siege, the English Government having conceived the idea of uniting Balaklava to Varna by a submarine electric cable, the Em-

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peror immediately directed that Varna should be attached to the German chains of telegraphs; accordingly, in a short time, in spite of every possible difficulty, the line from Bucharest to Varna, extending over 60 leagues, was completely established, and the communication was open some days before the completion of the submarine cable. Three Inspectors, 4 Directors, and 30 Station-men, at the four posts of Bucharest, Routschouk, Schumla, and Varna, insured a regular transmission of messages, which brought the army within a few hours of Paris.

PRINTING OFFICE.

A lithographic press set up at head-quarters met all requirements at the commencement; but afterwards, when the siege actually commenced, the constantly increasing number of orders to be transmitted, and the necessity for their arriving as speedily as possible at the different corps, determined the Commander-in-Chief to recommend that a complete printing establishment should be sent out to the Crimea. The Director of the Imperial Printing Office was entrusted with the management of the arrangement for its transport; and, until the evacuation of the Crimea, a foreman and two printers were constantly attached to head-quarters.

THIRD PART—MARITIME TRANSPORT.

The Imperial Marine, without slackening its exertions for meeting the numerous demands made on its services, supplied in addition, the following vessels for the transport of the troops:—

11 Ships of the Line, steam and sailing.
21 Sailing Ships.
19 Sailing Frigates.
24 Transports, steam and sailing.
19 Steam Frigates.
21 Corvettes.
and 17 Avisos.

In all, 132 vessels, which made 905 voyages, and carried backwards and forwards (for the land forces only) 273,780 men, 4,266 horses, and 116,661 tons of stores.

The English Government placed at the Emperor's disposal 8 ships of the Royal Navy, and 42 merchant vessels hired by the Admiralty, which transported to the East, in all, 38,353 men, 1,972 horses, and 6,624 tons of stores.

The Ministry of War hired, in 1854-55, 66 steamers, and 1,198 sailing vessels of all sizes. The 66 steamers, with 22 large clipper ships, composed a sort of fleet, which made regular passages back and forwards between the East and the ports where supplies were concentrated, during the entire continuance of the war. The packet-boats of the *Compagnie des Messageries Impériales*, in consequence of contracts concluded at the commencement of the war, transported infantry and stores, at the rate of two voyages in a week. For the return home of the army, the Ministry continued to employ 48 steamers, and 253 sailing vessels, of

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which 14 were large clipper ships. Altogether, the transport effected by the War Department amounted to 224,270 men, 44,736 horses or mules, and 601,251 tons of *matériel*.

In addition to the above-stated means of transport, the Intendant-General in the Crimea, and the Military Intendant employed at Constantinople, hired a large number of vessels to serve in provisioning the army. These ships were employed exclusively in carrying to the Crimea, the food and forage purchased on the coast of the Black Sea, and in Turkey generally.

The total maritime transport may be summed up as follows:—

	Men.	*Horses.*	*Tonnage.*
Sent to the East,	309,268	41,974	597,686
Returned from the East,	227,135	9,000	126,850
Total going and returning,	536,403	50,974	724,536

These totals may be sub-divided as under:—

	Men.	*Horses.*	*Tonnage.*
Carried by the Imperial Navy,	273,780	4,266	116,661
Carried by the English Vessels,	38,353	1,972	6,624
Carried by the Merchant Fleet and by Packet-boats,	224,270	44,736	601,251
	536,403	50,974	724,536

The men and stores embarked at Marseilles, reached that port for the most part by the railway between Paris and the Mediterranean: if this line had not existed, the operations of the war would have been certainly deprived of much of their rapidity and concert. His Majesty the Emperor, by reflecting on the events of a few years back, may recal with satisfaction, that one of the first acts of his energetic administration was to remove the obstacles that at the time existed to the completion of this great line, which has contributed so opportunely to the brilliant success of his army.

(Signed) VAILLANT.

Marshal of France; Minister and Secretary of State for the Department of War.

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ANNUAL REPORT.

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ANNUAL REPORT

AND

PROCEEDINGS OF A GENERAL MEETING,

HELD ON MONDAY, 20th JULY, 1857.

The Committee of the Royal Artillery Institution beg to submit the Annual Report:—

The following table shews the progress and present state of the Institution with respect to numbers of Members.

Rank.	£ s. d.	April, 1856.	Since Joined.	Promoted or Withdrawn	Deceased.	April, 1857.
EFFECTIVE LIST.						
General and Regimental Field-Officers paying annually,	1 5 0	127	+ 5	— 3	—4	125
Captains „	0 16 0	277	+12	—11	—2	276
Lieutenants and Quarter-Masters „	0 10 0	230	+29	—11	—2	246
Lieutenants „	0 8 0	12	+33	—15	—0	30
RETIRED LIST.						
General and Regimental Field-Officers paying annually,	1 5 0	10	+ 3	— 1	—1	11
Do. Do.	0 7 6	16	+ 0	— 0	—0	16
Captain paying annually,	5 0 0	1	+ 0	— 0	—0	1
„ „	1 0 0	1	+ 0	— 1	—0	0
„ „	0 16 0	15	+ 1	— 1	—0	15
„ „	0 5 0	19	+ 2	— 0	—0	21
Lieutenants, „	0 10 0	5	+ 0	— 0	—0	5
	Total,...	713	+85	—43	—9	746

The following is an Abstract of the Accounts for the year ending 31st March, 1857, shewing a balance Creditor of £182 9*s.* 1*d.*, in addition to £500 invested in 3 per cent Consols Stock.

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GENERAL ABSTRACT OF THE INCOME AND EXPENDITURE OF THE ROYAL ARTILLERY INSTITUTION, FROM 1st APRIL, 1856 TO 31st MARCH, 1857.

INCOME.

		£	s.	d.
By Balance Creditor, 1st April, 1856.	Consols Stock, ...	500	0	0
	Cash, ...	212	11	7½
„ Subscriptions, ...		649	1	6
„ Dividends on Consols, ...		14	0	0
„ Printing & Publication.	Printing for Adjutant-General's Office,	35	0	0
	General Printing, ...	70	14	5
	Sale of "Handbooks", ...	31	19	8
„ Drawing Class....	Instruction, ...	38	4	9½
	Materials, ...	4	5	11½
„ Sale of Photographic Materials, ...		5	13	7½
„ „ Turning Materials, ...		0	11	5
„ „ Paper, ...		2	13	6
„ Overcharges, ...		0	10	7
		£1565	7	1

EXPENDITURE.

		£	s.	d.
Chemistry—Materials, ...		28	5	11
Drawing.....	Instruction, ...	54	12	0
	Materials, ...	7	15	6
Lectures, ...		0	1	6
Printing and Publication...	Dalziel—Wood Cuts, ...	31	1	9
	Wages, ...	92	7	1
	Materials, ...	162	15	5
	Paper, ...	91	11	4
Furniture, ...		6	5	10
Instruments, ...		4	8	6
Library, ...		95	16	2
Museum, ...		32	5	8
Observatory, ...		6	2	2
Photography, ...		173	18	3
Postage and Parcels, ...		7	7	1
Repairs, ...		0	7	11
Stationery, ...		0	12	0
Turning Room, ...		30	2	5½
Wages, ...		45	8	6
Incidentals, ...		13	12	11½
Due to Institution, ...		3	0	0
Balance	Consols Stock, ...	500	0	0
	Cash, ...	182	9	1
		£1565	7	1

C. W. YOUNGHUSBAND, Captain, R. A.,
Secretary and Treasurer.

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It will be seen that the expenditure under the head of "Printing and Publication" exceeded the receipts by £240 1*s.* 6*d.*, this excess, which was caused by unusual outlay on account of the "*Handbook*", has been more than covered, by the receipt since 1st April of £403 10*s.*, and other small sums, in payment of "*Handbooks*" sold.

The balance to the credit of the Institution on the 30th June amounted to £994 8*s.* 5*d.* in cash, and in addition to £500 Consols Stock. As the sum in cash in the Agent's hands is much more than sufficient to meet the probable current expenses of the year, the Committee propose to invest a further sum of £500 in Government securities.

Classes and Lectures.—The classes for French, German, Landscape Drawing, and Field Sketching and Surveying, continue to meet regularly: a Chemical Class was formed and met weekly during the winter months.

Since the last General Meeting the Lectures to the Practical Class of Gentlemen Cadets have been delivered in the Lecture Theatre by the several Professors, four times weekly during the half-yearly terms of the Academy, and have been generally well attended.

Photography.—Since the last General Meeting, a Photographic Room has been built upon the roof of the Lecture Theatre. The expense of this room was in the first instance defrayed by the Institution, but has since been repaid to the Institution by the Government; a credit under this head for £99 14*s.*, the exact sum the Institution advanced for the purpose, will be shewn in next year's account.

Instruction in the preparation of the Chemicals has been given, by Mr. Abel, to several Officers who joined the Chemical Class with that object; practical instruction in Photographic Manipulation has also been given by Mr. M'Kinlay to these and other Officers who availed themselves of the opportunity.

The only Camera hitherto possessed by the Institution being now found inadequate to supply the requirements of Photographers, the Committee have made arrangements for procuring a large Camera, with a large Landscape Lens, and all requisite apparatus.

Printing and Publication.—The Second Edition of the "*Handbook*" was completed during the month of April in accordance with the arrangements previously made, as announced at the last General Meeting; 1250 copies were supplied to the Government for the use of Artillery Serjeants, and a further demand for 250 copies has been fulfilled. These 1500 copies have been paid for by Government at the rate of 5*s.* per copy, being an advance of 1*s.* 6*d.* on the price originally contracted for; the higher sum was agreed to on the completion of the book, in consideration of the additional matter contained in it. The East India Company have been supplied with 60 copies at the same rate.

The arrangements respecting the price to Officers and others are as

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follows:—1 copy to each Officer (Member of the Institution) half the above rate, or 2*s.* 6*d.*; any additional copies 5*s.* each. To the public 7*s.* 6*d.* each.

Museum.—The progress in the setting up of specimens of Birds, and other objects of Natural History, has been satisfactory. A very valuable addition has been made to the Museum of a case of Models illustrating the "Art of Travel"; for this, the Institution is indebted to Mr. Francis Galton, whose extensive experience as a traveller in uncivilized countries, and whose well known ingenuity in turning to good account the materials procurable in any locality visited, have thus enabled him to furnish practical lessons of the highest value to all campaigners. The models, with the explanations which accompany them, are well worthy of careful study.

Among other additions to the Museum, the Committee notice specially, some rare fossils, fragments of pottery, porphyry, &c., from the Crimea, presented by Lieut.-Colonel Aylmer; some Crimean bird skins, by Lieut. Blakiston; and a very valuable collection of bird skins, land and fresh water shells from the West Indies, by Lieut. Francis Lyon, R.H.A.

The additions to the Library include Gould's "Birds of Asia", a companion work to those magnificent books, Gould's "Birds of Europe", presented by Major-General Whinyates; the "Encyclopædia Brittanica", new edition, and other books of less note.

Committee.—The following Officers retire from the Committee by rotation, in accordance with Rule IV:—

Colonel F. M. Eardley-Wilmot.
Captain F. A. Campbell.
Captain E. Palmer.
Captain B. Parkin.
Major H. W. J. Dashwood.

Also, Colonel R. Barker, under orders for Foreign Service.

It was then RESOLVED:—

I. That the Report of the Committee be adopted.

II. That Messrs. Cox and Co. be instructed to purchase £500 Stock, 3 per cent. Consols, on account of the Institution.

III. That the under-mentioned Officers be elected to supply vacancies in the Committee:—

Lieut.-Colonel W. J. Smythe.
Lieut.-Colonel C. J. B. Riddell.
Captain O. R. Stokes.
Lieut. H. J. Alderson.
Lieut. H. D. Pitt.

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The Committee will then stand thus:—

PATRON AND PRESIDENT.

General H.R.H. The Duke of Cambridge, K.G.

VICE-PRESIDENTS.

The Adjutant-General.
The Director-General.
The Commandant.

MEMBERS.

The Senior Assistant-Adjutant-General.
The Secretary Ordnance Select Committee.
The Brigade-Major.

Colonel E. N. Wilford.
Colonel J. Fitzmayer, C.B.
Lieut.-Colonel W. J. Smythe.
Lieut.-Colonel C. J. B. Riddell.
Captain H. Clerk.
Captain O. R. Stokes.
Captain A. Orr.
Major W. H. R. Simpson.
Captain G. K. Taylor.
Lieut. W. L. Yonge.
Lieut. J. Hanwell.
Lieut. H. J. Alderson.
Lieut. H. D. Pitt.
Dr. J. M. S. Fogo.

Captain C. W. Younghusband, *Secretary and Treasurer.*

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Additions to the Museum and Library since the last General Meeting.

Presented to the Museum.

A Box of Fossils, from Kertch. *Lieut.-Colonel Graydon, R.A.*
Case of Models illustrating the Art of Travel. *F. Galton, Esq.*
Fossils, fragments of Pottery and Porphyry, from the Crimea. *Lieut.-Colonel Aylmer, R.A.*
Bird Skins, various, from the Crimea. *Lieut. Blakiston, R.A.*
A Bottle of Insects, from the Crimea. *do.*
Ancient Pottery, &c., from Honduras. *Lieut. F. Lyons, R.H.A.*
Birds and Animals, Land and Water Shells, and 2 pieces of Sword Fish. *do.*
Fossils, from Sevastopol. *Captain Dames.*
Bird Skins, from the Crimea. *Lieut. Tweedie.*
A Model of an Arab Tent. *Mrs. Tanswell.*
An Iron Gun, from Kertch. *Colonel C. Dickson, C.B., R.A.*
Fragments of Pottery found in digging foundations in the Boring Department, Royal Arsenal. *Lieut.-Colonel E.-Wilmot.*
An Iron Bucket for carrying Hot Shot, used by the Russians; taken at Sevastopol. *Colonel St. George, C.B., R.A.*
Two Casts of the Scull of Montcalm. *Lieut.-Colonel Beatson, R.E.*
One Koodoo, 1 Hartebeeste, 1 Waterbuck from Africa. *Lieut.-Colonel Faddy, R.A.*
Fox from South Africa. *Lieut. Stewart, R.A.*
Bird Skins, various, from Asia. *J. Gould, Esq.*
Two Opossums, and two Asiatic Birds. *Mr. Whitely.*
Sword, from the Crimea. *Lieut.-Colonel Aylmer, R.A.*
Case of Butterflies, from China. *Lieut. Carey, R.A.*
Case of Ferns. *Lieut. Strange, R.A.*
Case of Butterflies. *Lieut. Yonge, R.A.*

Books Presented.

Art of Travel, 1 vol. *F. Galton, Esq.*
Comptes Rendus Hebdomadaires des séances de L'Académie des Sciences, 2 vols. *Captain Noble, R.A.*
Morgan's Calculus, two vols. *do.*
Papers printed in the Asamese Language. *Lieut. Cane, R.A.*
Military Engineering, 1 vol. *Mr. R. Forrest.*
Incorporation of Artillery with Cavalry and Infantry. *General Sir R. Gardiner, K.C.B., R.A.*
Is England a Military Nation or not? *do.*
MSS Work on the Indian Army. *Captain Anson.*

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Books Purchased.

Tabular arrangement of Battalion Drill, 1 vol., by Sir Thomas Troubridge.

Barlow's Tables of Squares, Cubes, and Roots, &c., 1 vol.

Explanations of the Manœuvres of a Brigade of Infantry, 1 vol.

Cassells' Euclid, 1 vol.

Goulds' Birds of Asia, 8 parts.

The Seat of War in the East, by Simpson, 2 vols. folio., 81 plates.

Sketches in the Crimea, by Major C. H. Owen, R.A., 1 vol.

Sketches in the Crimea, by Captain Dames, R.A., 1 vol.

Field Exercises and Evolutions of the Army as revised in 1833, 1 vol.

Encyclopædia Brittanica, 8th Edition, (13 vols. received, and to be continued.)

Aide Memoire à l'usage des Officiers D'Artillerie, 1 vol.

Various French Professional Works, 43 parts.

Shells and Shell-Guns, by Commander Dahlgren, U.S.N.

Mathematical Tables.—Chamber's Educational Course.

The Measures, Weights, and Moneys of all Nations, by W. S. B. Woolhouse.

Adcock's Engineer's Pocket-book.

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Experiments connected with the comparative strength of Iron used in the Manufacture of certain Mortars, in relation to their enduring properties when fired with Service Charges, and the mechanical tests to which the Iron can be subjected in the machine; carried on under the direction of the

SUPERINTENDENT ROYAL GUN FACTORIES.

The experiments here reported have been carried out under the direction of Colonel F. Eardley-Wilmot, Royal Artillery, Superintendent Royal Gun Factories, by Mr. P. M'Kinlay, Proof Master, who conducted the trials and tested all the specimens connected with them.

The roughing out and preliminary preparation of the specimens was performed by lads; the accurate finishing and gauging by Robt. M'Kenzie, metal-turner.

The Specific Gravities were taken and the Testing Machine worked by George Simm, labourer.

The Computations are by Robert Smith, computer.

The Chemical Remarks and Analyses are by F. A. Abel, Esq., Chemist to the War Department.

The American Testing Machine has been very materially improved from time to time, by the addition of indices, &c., to measure the amount of deflection or extension, &c., previous to fracture, by Mr. M'Kinlay. While it is probable that the results, as represented in pounds on the square inch, may be somewhat below the absolute values, yet they may be depended on for comparison among each other.

In the operation of testing, great care has been taken to keep a comparatively uniform temperature of 60° in the room, and to occupy the same time in each and every operation on the separate specimens.

REPORTS ON 13-INCH SEA SERVICE MORTARS.

The failure of many 13-inch Sea Service 5 ton Mortars at the bombardment of Sweaborg in August, 1855, was a result wholly unexpected.

The form of these Mortars is that which has been long adopted in the Service, having been arrived at after careful consideration, and they were sent in the Mortar-Boats without the least anxiety as to the result.

Of the sixteen Mortars used on that occasion, three were burst, and all were rendered unserviceable, owing to the wearing away of the metal at the bottom of the chamber.

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The rate of firing did not (except in one case) exceed 30 rounds per hour, and in very few cases exceeded 20, the charge used varied from 12 to 18 lbs., the full service charge being 20 lbs.

Previous to the receipt of the above intelligence, orders had been issued for a further supply of Sea Service Mortars for use against Sevastopol, and it became a question of serious importance as to how far these might be obtained of a suitable quality.

The unusual circumstance of the bursting of a 13-inch Mortar on proof, and shortly after, the bursting of another at the third round, on board a Mortar-Boat, attended with serious injury to the Officer and Men, created much anxiety, and orders were given to test to bursting with a service charge, two Mortars furnished by each maker. This had been only partially carried out when the demand for Mortars ceased, and there still remains a portion of this experiment of considerable interest and importance, which it is desirable to complete.

After the above-mentioned experience, it was considered desirable to add the mechanical test to that of the proof by firing, and it was arranged that with each mortar supplied by a contractor, a half disc of the dead-head cut off close to the muzzle, was to be furnished, out of which specimens to be tested were to be cut.

The result of these tests are shewn in the second series of tables, while the letters and reports will give a general idea of the whole subject as regards the first series.

Woolwich, September 25th, 1855.

Sir,

In accordance with the instructions conveyed in the two memoranda, respectively dated 22nd September, I have the honor to forward a paper giving the place of manufacture, &c., of the several Mortars which were used at Sweaborg, pointing out the defects which have appeared in each, together with such information as appears to me desirable to add on this important question.

I have received no information as to the failure or otherwise of any of the Iron Ordnance, or other Material, used in the Siege of Sevastopol.

The demand for Land and Sea Service Mortars appears to have been greater than was anticipated; and consequently it was soon found that the supply was totally inadequate. Under these circumstances the only means for meeting the emergency appeared to be the calling on the various large manufacturing firms to make Mortars. For this purpose the Inspector of Machinery made a tour through the Iron districts, and offered good terms to such parties as were willing to tender.

Subsequent information led to the belief that many of the Mortars so supplied would turn out to be of very inferior quality; and there was full confirmation of this point in the bursting on the ordinary proof, of a new 13-inch Mortar. As I have explained in my former letter, the proof is so very inadequate for the purpose of testing the real quality of the Mortar, that it is hardly worthy of the name of "proof;" this arises from the difficulty, in so

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crowded a locality, of firing a Mortar with a service charge, at a high angle of elevation.*

Just at this juncture the news arrived that several of the Mortars had burst at the bombardment of Sweaborg; news which naturally caused great anxiety, when I was aware of the probable character of many of the new Mortars daily coming in. In order to assist in this difficulty, I immediately ordered that the best wrought iron bands, two for each Mortar, should be made by Mr. Hughes of the Uskside Iron Works, Newport, South Wales, and shrunk on to 20 Mortars 13-inch land, and 20 13-inch sea service.

A 9-pr. Gun, strengthened with rings, had been previously ordered for trial by Lord Panmure, and given good results.

The following is the detail of the Mortars used at Sweaborg, and, as far as I can judge, the causes which in a measure, determine their bursting.

Report of the examination of 13-*inch Sea Service Mortars returned from the Baltic:—*

Rounds Fired.	No. of Mortar	Maker.	Weight.	Date of Casting.	Name of Vessel.	Vent. Top.	Vent. Bottom	Remarks.
			c. q. lbs					
230	6391	Low Moor.	102 3 18	1855	Redbreast.	True	1·2	Hole in bottom of Chamber filled with metal.
311	83053	Carron.	102 1 3	1814	Grappler.	·25	1·85	Pin hole from firing ·21 in. deep in bottom of Chamber.
113	6343	Low Moor.	102 3 20	1855	Sinbad.	True	1·7	Hole in bottom of Chamber 2·4 in. long, 1·7 in. wide, and 1·95 deep.
134	82039	Carron.	101 1 13	1813	Surly.	·25	1·45	Hole in bottom of Chamber filled with metal. Roberts' Sling.
389	81644	Do.	101 1 25	1813	Carron.	·25	1·45	Hole in bottom of Chamber 2·1 in. long, 1·5 in. wide, and 2·6 in. deep.
241	6344	Low Moor.	102 0 10	1855	Rocket.	True	1·7	Pin hole in bottom of Chamber from firing 3·75 in. deep.
176	81994	Carron.	101 3 3	1813	Beacon.	Full	1·55	Hole in bottom of Chamber filled with metal.
148	83106	Do.	100 3 22	1813	Mastiff.	Burst.		Hole in bottom of Chamber 5 in. deep, and 3·3 in. wide.
355	82187	Do.	101 2 17	1813	Growler.	Do.		Hole in bottom of Chamber 1· in. deep, 1·55 in. wide cracks. Roberts' Slings.
114	6390	Low Moor.	102 3 0	1855	Pickle.	Do. one-half returned.		Hole in bottom of Chamber 3·5 in. deep, and 2·55 in. wide.

In the above Mortars the effect of heavy firing appears to be very similar, though in some cases there are more fissures in the chamber than in the

* In 1786, "Mortars are to be proved by firing two rounds at 75° elevation, with the chamber filled with powder, and a solid iron ball of equal diameter of a shell of the calibre."

In 1855, Charge 20 lbs. 11 oz., solid shot, *fired horizontally.*

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others. The introduction of an alloy of Tin and Zinc into the holes appears to have been so far useful as to have prevented the entrance of the gas, and deadened the blow caused by the discharge.

The appearance of all confirms the opinion usually held by the profession, that the effect of a discharge is somewhat similar to a blow, breaking off a portion of the metal.

The expansion of the interior of the bore is resisted by the surrounding mass, and by frequently returning to its original position the interior becomes cracked, and when once this effect commences, a succession of similar blows rapidly adds to the mischief.

The remedy for this appears to be the use of a superior metal, having greater tenacity and elasticity, and therefore allowing of a less thickness being used.

The direction of the split in a vertical line, appears somewhat determined by the resistance offered (in the direction perpendicular to this) by the Mortar bed checking the motion in the vertical direction. The Mortars have all split through the vent, the hole determining the exact *place* of fracture the direction being given; or it is possible that the position of the vent may have directed the fracture. It will be easy to prove this by placing the vent in some other position.

It is generally known that some of these Mortars were fired about 30 rounds in one hour, a strain and wear requiring good metal; at the same time it is quite possible that success in the important operations of war may depend on rapidity of fire, and our Mortars ought to be prepared accordingly.

It is I believe impossible to judge with sufficient accuracy of the strength of Iron from its appearance, as some think, nor does the chemical test afford complete assistance, the best Iron used in Russia, of immense tested strength, not perceptibly differing from "Low Moor."

I purpose cutting bars from the "Sweaborg" Mortars, and testing them by mechanical means.

I have already proposed a new form of Mortar, which it is thought may give good results.

In order to obtain Iron Ordnance of the required quality, and equal to such as is used in several other countries, it is absolutely necessary to introduce a system of manufacture different from, and in many respects the opposite of that pursued in England, this system embracing every detail of manipulation, the Iron and the Fuel.*

The Iron of this country is mostly from Secondary Ores, more or less mixed with deleterious substances, and naturally impure. The mineral fuel, coal, nearly always contains sulphur, the slightest indication of which is highly injurious to Iron, rendering nugatory every precaution, and making the best ores to produce weaker Iron. Ordinarily, where the object is to produce *quantity*, and not *strength*, when recourse is had to hot blast of sufficient power to reduce the most refractory material, and the fuel is frequently raw coal glistening with sulphur, then the result is a weak Iron more suitable than any other for a variety of purposes, and yielding a large

* I do not now allude so much to those firms whose attention has long been directed to this important subject, as to those suddenly called on, in such an emergency as this to supply war *materiel*, in the production of which they have no experience.

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profit. Such Iron is useless for Ordnance, and should not be employed, but being extremely cheap, there is a great inducement to mix it with such a proportion of stronger metal, as will produce Guns or Mortars capable of standing the ordinary proof.

To this contingency the Government are continually exposed, arising from the competition of trade, which induces a contractor who has no experience of the force of Gunpowder, and with no desire to do wrong, to offer a supply at a lower price. Under the best circumstances, there is always a direct connection between inferior metal and profit, the cost of manipulation, and its apparent excellence being the same.

To obtain Guns and Mortars of the right quality, no expense must be spared in procuring Iron of the best quality. It is a burlesque of British Ordnance that orders are given against the Gun being fired with an elevation beyond a certain limit, and a charge of powder below that known to give the best effect. It is well known that on late occasions the shot from the Russian Guns, supposed to be beyond our range, passed quite over our ships.

The Iron Ores of Sweden and of Nova Scotia, are of very superior quality, are smelted with charcoal, (free from sulphur) and the product is very valuable, and admirably suited for Ordnance. It is most desirable that means be taken to secure a proper supply from the vast resources of our colony of Nova Scotia, which contains mountains of this precious metal.

The method of casting in this country has hitherto been, to cast the Iron into a solid mass, of the shape of the exterior diameter of the Gun, and afterwards to bore the Gun (or Mortar) out of this solid block. This block has a long dead-head of metal in order to obtain sufficient density by the fluid pressure while the metal is in a molten state. The metal has hitherto been poured in through the upper end of the mould and this dead-head acts as the fountain for supplying metal to the mass when cooling and shrinking.

It has long been considered by all acquainted with these matters in the employment or otherwise, of the Government, that by the above process, the tendency of the cooling mass is to exhaust the interior, the solidification taking place first on the exterior. This defect was the less observable as the Gun had to be bored out, so that a *portion* of the inferior metal was removed.

In order to improve the character of Cast-Iron Guns, an effort was made a few years ago in the United States, under the superintendence of Major Wade, to cast Guns on a core, means being employed to keep the core moderately cool. It is desirable also to reduce the tendency to give out heat by surrounding the mass with some non-conducting material. In spite of many practical difficulties, this process has been succesfully carried out.

Some of the Guns made in this manner, (said to be of Nova Scotia Iron) have withstood several thousand rounds; and it is proposed to make a similar attempt with some analogous method. The Gun ought to be cooled slowly, obtaining *strength*, (the *vital point)* at the expense of time and care. Every change towards perfection in this manufacture diminishes profit; and the final result can only be obtained by persevering in a direction thus indicated, until it is accomplished.

Such a course of experiments will not pay any contractor, unless by a rate of remuneration far beyond its absolute value.

A Government manufactory will alone afford a secure guarantee that all

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will be done to accomplish the end in view, viz., the raising the strength of Iron Guns from 17,000 to 35,000 or 40,000 lbs. on the square inch, and thus form a standard of comparison with Ordnance which must continue to be procured by contract. The results of the American system were mentioned last year by Col. Burn, R.A., and those connected with him, in the able Report of the Committee on those general subjects.

It may be possible and proper to get a supply of Guns occasionally from Sweden, but independently of the uncertainty of all foreign supply, will the British Government condescend to be indebted to another nation for such an article of manufacture, their own colony of Nova Scotia teeming with ore and wood suited for the purpose?

This question is not one simply of economy. Yet even on these considerations it might evidently be right to entertain it.* But without desiring that a Royal Factory should make all the Guns and Mortars required, it is essential that it be founded as a means of testing quality, and urging the private trade to the utmost.

Large calibre Guns and Mortars are being urgently called for, and it is not improbable that, for coast defences at least, we must greatly augment our power in this particular, if we intend to keep an enemy's ships at a distance.

If quality is to be obtained, it must be paid for very highly, and will always be liable to fall off during emergencies.

In the manufacture of so peculiarly a speciality, on which so much depends, the Government might well be its own manufacturer, without damage to mercantile interests, and with the soundest policy.

F. EARDLEY-WILMOT,
Lieut.-Colonel, Royal Artillery,
Superintendent Royal Gun Factories.

Right Honble. W. MONSELL, M.P.

Observations on the Sea Service Mortars used at the Bombardment of Sweaborg in August, 1855, for the information of the Commander-in-Chief.

The cavities in the bottom of the chambers mentioned in the annexed Report varied in depth from 1 to 1¾ inches.

The repairs were effected by introducing melted zinc into the cavity, which lasted usually from 12 to 30 rounds.

The Mortars which burst were divided through the whole course of the vent, the cavities in the chambers were found to be larger after each repair, they inclined downwards.

The vents of the Mortars inclined towards the breech, and this seems in some degree the cause of those cavities.

The "Growler's" Mortar cast in 1813 answered well. Had all been equally good it is probable that the same injury might have been done to the town in so much less time, and the Mortars would still have been fit for service.

The destruction caused by the bombardment may be considered partly owing to the rapidity of the fire, it prevented the enemy (probably) from

* The increase of price during any emergency being upwards of 25 per cent.

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extinguishing the flames, which may have been rendered more intense by their occurring in so many places at once.

In Naval Bombardments rapidity of fire is very essential, the men being unprotected by epaulments, and the action being liable to be impeded by bad weather.

In the old works on Naval Gunnery, more particularly in that of Lieut. Brancham, Royal Marine Artillery, it appears that Mortars were supposed to throw about 25 shells per hour, at the bombardment of Sweaborg they averaged 25 to 30 shells in the first hour, and fewer in subsequent hours. The only Mortar which exceeded 30 rounds in one hour, was that in the "Growler," which lasted best of all during this rapid firing, every shell appeared to be effective.

The Valenciennes Composition seems to have been destructive.

As the Mortars varied much in their powers of endurance, it is submitted that some may have been made of inferior metal.

The "Growler's" swinging Mortar, had its suspension gear in good order throughout 355 rounds.

In the other three, the bolts supporting the muzzle band gave way. Two of them answered well with chains instead of a band; for the third, new bolts were made. With perfectly good materials this system presents great advantages and a constant elevation in a sea way is an important consideration; but an accident causes great delay, and changing a sling Mortar for another would be attended with considerable difficulty.

(Signed) J. M. WEMYSS,
Captain Commanding Detachment Royal Marine Artillery,
attached to Baltic Fleet.

August, 20, 1855.

Report of the state of Mortars on board Her Majesty's Vessels after the Bombardment of Sweaborg, on the 9th and 10th August, 1855.

N.B.—Repairs of Mortars were made by running zinc and tin into the cavity at the bottom of the chamber.

"*Blazer*," 129 *Rounds.*

Second repair of Mortar; split down the bottom of the chamber; vent blown.

"*Grappler*," 311 *Rounds.*

Mortar not repaired; split down the bottom of the chamber; vent blown.

"*Prompt*," 184 *Rounds.*

Third repair; vent blown; cavity at the bottom of the chamber, deep.

"*Porpoise*," 213 *Rounds.*

Fourth repair; vent blown, and rent at the bottom of the bore, in line with the longitudinal crack in the vent; cavity at the bottom of the chamber, very deep.

"*Surly*," *Swing Mortar*, 134 *Rounds.*

Fourth repair; number of rounds between each repair 14, 34, 30; vent blown; suspension gear carried away first day's firing; second day fought in chains.

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"*Drake*," *Swing Mortar*, 129 *Rounds*.

Third repair; number of rounds between each repair, 22, 65; vent blown; suspension gear carried away; slung in chains; trunnion rods bent.

"*Redbreast*," 230 *Rounds*.

Third repair; number of rounds between each repair, 61, 30; vent blown.

"*Havock*," *Swing Mortar*, 94 *Rounds*.

First repair; bolt of muzzle strap replaced once; vent blown.

"*Sinbad*," 113 *Rounds*.

No repair; disabled the first day by a large cavity at the bottom of the chamber, from which a crack extends over the crown of the chamber through the vent, and a crack extends from the same cavity, to the lower part of the chamber.

"*Pickle*," 114 *Rounds*.

Mortar burst first day; no repair; cavity in the end of bore, conical apex turning downwards.

"*Growler*," *Swing Mortar*, 355 *Rounds*.

Mortar burst second night; no repair; fired 355 rounds without cessation; bottom of chamber slightly injured; no cavity.

"*Mastiff*." 148 *Rounds*.

Mortar burst second night in 4 pieces, 2 large and 2 small; one of the smaller went overboard; one repair.

"*Carron*," 289 *Rounds*.

Fourth repair, about 16 rounds between each repair; split down the bottom of the chamber; vent blown; cavity at the bottom of bore, deep.

"*Manly*," 277 *Rounds*.

Second repair; split down the bottom of bore; five large cracks in the chamber, one of them through the vent, which is blown.

"*Beacon*," 176 *Rounds*.

Sixth repair; about 14 rounds between each repair; cavity at bottom of chamber, deep; vent blown.

"*Rocket*," 245 *Rounds*.

No repair; a large rent in crown of chamber, extending through the vent which is blown; a small cavity at bottom of chamber.

Total No. of Rounds 3141.

The above Report was drawn up by Captain Schomberg, Royal Marine Artillery, and I consider it to be correct.

(Signed) J. M. WEMYSS,
Captain Royal Marine Artillery.

Notes on Testing Dead-Heads of 13-inch Sea Service Mortars.

In November, 1855, arrangements were made for testing the metal used in the manufacture of 13-inch Sea Service Mortars, the contractors for this species of Ordnance had to supply with each piece, a sample of the metal taken from the dead-head, that portion of it nearest the face of the Mortars

The samples supplied were half discs, about four inches in thickness. These

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were cut up into specimens for Tensile and Transverse testing.

The specimens were taken from different parts of the sample, and in different positions, in order to test not only their actual, but also their comparative strengths, according to the following scheme. (See diagram 2 a.)

No. 1 A, B, in the direction of a tangent to the bore, A the outside, B inside.

No. 2 A, B, at right angles to the above and in the same plane.

No. 3 A, B, at right angles to the former, but not in the same plane with either.

C, intermediate to the other specimens, in the same plane with Nos. 1 and 2.

The specimens marked A were taken from the outside of the slab, B the inside, and C the centre.

The Tensile specimens were turned into cylindrical pieces (as shewn in diagram) length 2·8 in., diameter of top and bottom 1·8 in., and the centre or line of breakage 1·3 inches. The breaking weight per square inch determined by the formula

$$S = \frac{w}{a}$$

S = Tensile Strain.
a = Area.
w = Observed Breaking Weight.

The Transverse specimens were taken from the part marked A and B, as near to the bore as possible, they were two feet in length, and four inches in the cross section, (2 × 2), and determined by the formula

$$S = \frac{l\,w}{4\,b\,d^2}$$

S = Tranverse Strain.
l = Length between supports (in this case 20 inches.)
w = Observed Breaking Weight.
b = Breadth.
d = Depth.

The result gives the weight the same metal would bear, if the strain was applied at one inch from the point of support, the bar being 1 inch square, and fixed horizontally.

The density of the specimens was taken before testing, and recorded in the column marked "specific gravity."

The firms supplying Mortars under this contract, and the samples tested, were as follows:—

Messrs.	Armstrong, Elswick Iron Works, Newcastle,	8
„	Butler, Stanningly Iron Works, Leeds,	8
„	Crosskill, Beverley Iron Works, York,	8
„	Fawcett, Preston, & Co., Liverpool,	16
„	Peel, Soho Iron Works, Manchester,	3
		43

From each sample 7 Tensile and 2 Tranverse specimens were tested, making in all 387.

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REMARKS ON TABLE II.

MESSRS. ARMSTRONG.

(Mortars Cast on a Core.)

The samples supplied by this firm are of uniform strength, the outside and inside specimens being nearly equal, the centre ones are the lowest; in one case only does this class exceed the mean.

The following summary shows the order of strength in the different combinations, taken from mean results.

Order of Strength,	1st Outside, 2nd Inside, 3rd Centre,	specimens.	Order of Strength,	1st No. 3, 2nd „ 2, 3rd „ 1, 4th „ C,	specimens.

MESSRS. BUTLER.

(Mortars Cast on a Core.)

The samples of this set differ in many respects from the preceding, as will appear by the summary.

Order of Strength,	1st Inside, 2nd Centre, 3rd Outside,	= specimens.	Order of Strength,	1st C, 2nd No. 2, 3rd „ 3, 4th „ 1,	specimens.

MESSRS. CROSSKILL.

(Mortars Cast on a Core.)

The samples of this firm bear a strong resemblance to those of Messrs. Butler, the order of strength and degree are nearly identical. It may be observed that the inside and centre specimens of both sets, are not only in the same order, but that they are equal to each other.

Order of Strength,	1st Inside, 2nd Centre, 3rd Outside,	= specimens.	Order of Strength,	1st C, 2nd No. 1, 3rd „ 2, 4th „ 3,	specimens.

MESSRS. FAWCETT, PRESTON, & CO.

(Mortars Cast on a Core.)

The Mortars from this firm were cast solid with the exception of No. 26, the summary of which is here given, for comparison with the preceding.

In this case, there is a perfect coincidence with the samples of Messrs. Armstrong, in the order of strength, but not in degree.

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Order of Strength,	1st Outside, 2nd Inside, 3rd Centre, } specimens	Order of Strength	1st 3, 2nd No. 2, 3rd „ 1, 4th „ C, } specimens.

(Mortars Cast Solid.)

This Series has no similitude with any other.

Order of Strength,	1st Outside, 2nd Centre, 3rd Inside, } specimens	Order of Strength	1st No. 2, 2nd „ 3, 3rd „ 1, 4th „ C, } specimens.

MESSRS. PEEL & CO.

Mortars Cast Solid.)

The samples of this firm bear a close resemblance to those of Messrs. Fawcett, and Armstrong, cast on *core*.

Order of Strength,	1st Outside, 2nd Inside, 3rd Centre, } specimens	Order of Strength.	1st No. 3, 2nd „ 1, 3rd „ 2, 4th „ C, } specimens.

The Centre specimens (marked C) are either the *strongest* or *weakest* of the series, twice in the former case and four times in the latter.

It will be remarked, that nearly in all cases, the position of the specimen of greatest strength is at right angles to that of the weakest, indicating a fibrous arrangement of atoms in cast Iron, as seen in the fractures of zinc, and other metals of a crystalline structure.

The order of strength and specific gravity agree in the following cases, viz.:—

Armstrong, ...3	out of 6	being	the	Outside, One, and Three,	specimens.
Butler,.....2	„	„	„	Outside and Centre,	
Crosskill, ...1	„	„	„	Three,	
Fawcett, Core 2	„	„	„	Centre and Three,	
Fawcett, Solid 3	„	„	„	Outside, Inside, & Centre,	
Peel,.....	„	„	„		

Transverse.

In the results by this mode of testing, the specimen whose upper surface coincides with the face of the Mortar, appears to bear a greater strain than that at right angles to it, another corroborative proof of the features observed in the tensile testing.

The ratios of three modes of testing (in terms of the highest) are given for comparison.

Specimens.	Armstrong	Butler.	Crosskill.	Peel.	Fawcett.	
					Core.	Solid.
Tensile, ...	·796	·746	·743	·887	·984	1·000
Transverse, ...	·799	·817	·806	·940	·985	1·000
Specific Gravity,	·977	·973	·973	·979	·995	1·000

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Of the foregoing Mortars those of Butler and Crosskill only, have yet been proved by firing; in the specific gravity, mechanical test, and chemical character, the metal of both appear indentical, yet the former burst in 64 rounds, while the latter stood 2001, and is not yet burst.

The metal by Messrs. Fawcett present such very high mechanical results that it is desirable to fire Mortars No. 26, cast on a core, and No. 37, cast solid, until bursting, as also Peel's No. 1.

Of other Mortars there are two by Messrs. Walker which it is most desirable to fire to bursting, one old and one new pattern, both cast on a core, from the same metal, and at the same time.

It is possible that the metal cut from the Mortar after firing, may have been to a certain extent altered by the jarring produced by the discharge, those portions taken from dead-heads present no such probability of disturbance.

General Remarks Relative to the Firing and Bursting of 13-*inch* 5 *ton Mortars at Shoeburyness, to test the Metal.*

There being a general impression in the service that the bursting of the Mortars at Sweaborg was owing to the rapidity of the fire, and this opinion having been more than once mooted in the House of Commons by Admiral Sir Charles Napier, it became absolutely necessary to test the truth of this supposition before any steps could be taken in the way of improvement in Mortars.

It may frequently occur that owing to there being but a narrow channel, (or other hinderance), but few Mortar-Boats can approach a sea fortress or town, and it is therefore essential that Mortars be capable of resisting the utmost rapidity of fire that it is possible for the well-known activity of the seamen to subject them to.

With this view Colonel Mitchell, Royal Artillery, who conducted the experiments at Shoeburyness, caused the Mortar under trial to be placed near to a small bomb proof, and having erected a light derrick touching the Mortar, had the shells ready for firing piled close to the muzzle. By this arrangement, and with the most perfect security, he was enabled to fire with a rapidity quite unexampled, frequently, and whenever he wished, at the rate of 75 rounds in 60 minutes, and very often having two shells from the same Mortar in the air at the same time.

The rate of firing was however frequently changed so as to test the Mortar to the utmost, and settle this important question once and for all.

The results are shewn in the tables.

From these tables the following observations are drawn, without any idea that they exhaust the subject.

Out of 18 Mortars,
- 14 burst into 2 pieces.
- 2 „ 3 „
- 2 „ 4 „
- 12 through the vent.
- 3 partially through.
- 3 not through.

No Mortar bursting into more than two pieces has exceeded 130 rounds, the mean of the four bursting into more than two pieces, gives

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106 rounds, the mean of the four lowest bursting in two pieces gives 51 rounds, but if we reject Nos. 1 and 12 of Messrs Grissell, 111 rounds.

It is generally considered that it is a sign of very inferior quality in a Mortar, to burst into more than two pieces.

Mechanical Tests.

From each burst Mortar a sample of the metal was taken for mechanical testing; a bar two inches square and 10 inches long was cut out of the muzzle, (diagram 1 a.), and broken transversely, from each end of this bar a cylinder was turned (diagram 2 a.) and tested by tensile strain; one specimen was taken from the outside, marked A, the other from the bore marked B. The results are detailed in the annexed table

In Mortars cast solid, when the tensile test indicates a higher result in the inside than the outside specimens, the firing result is inferior.

When they are nearly equal, or, the outside is the highest, a better result is to be looked for.

When the tensile result is high and the transverse low, the result is inferior.

A very low specific gravity, tensile, and transverse result, appears compatible with a greater firing result than superior qualifications in all these points, as Forrester, No. 1195, 112 rounds, Grissell, No. 12, 9 rounds.

As regards Hood's, No. 6940, cast on a core, and 6904 cast solid, from the same furnace, and at the same time, the superiority of the core Mortar is very marked as regards firing, but less so as regards the mechanical test.

Comparing the core Mortars of Hood and Crosskill, we find that the former has a high value mechanically, specific gravity and purity of iron, with a high firing result, whereas Crosskill has a moderate or low mechanical value and also a high firing result.

A high specific gravity is not always connected with a high firing result, as Grissell's No. 12, specific gravity 7·14, 9 rounds; and Begbie's No. 2, specific gravity 6·96, 103 rounds; nor does equal specific gravity indicate equal results; compare with the first of these, Dunlop's No. 3, specific gravity 7·17, 130 rounds.

A comparatively pure Iron is not always accompanied with a high firing result.

A high degree of elasticity as shewn by deflection appears to be of great importance.

Skill in treating the metal and in cooling it, appears to be of peculiar importance.

There is a general impression that a piece of Ordnance requires a certain time, in order that the particles may adjust themselves to their new position; and that it is better not to fire to excess until some weeks after the piece has been finished.

None of the Mortars had the bottom of the chamber injured as were those of the Baltic Fleet, except Crosskill's No. 6 slightly after 2001 rounds.

In order to complete this valuable series of experiments, it is most

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desirable, that the Mortars specified in the annexed list, should be tested to bursting at Shoeburyness, as they all possess some important features peculiar to themselves. I beg therefore to suggest that the necessary authority may be granted for this purpose, especially as regards those which stand first on the list, and to which I have alluded in a former part of the Report.

List of Mortars in the Royal Arsenal, which it is desirable to test to Bursting with Service Charges.

Name of Maker.	For what tested.	Remarks.
Fawcett, ... No. 26,	Endurance.	Cast on a Core.
Fawcett, ... No. 37,	do.	Cast Solid.
Peel, ... No. 1,	do.	Cast Solid.
Walker,..... No. 1,	do.	Cast on a Core, new pattern.
Walker,..... No. 1,	do.	Cast on a Core, old pattern.
Fairbairn,.... No. 1,	do.	Welsh Iron, new pattern.
Fairbairn,.... No. 3,	do.	Nova-Scotia from pigs, do.
Fairbairn,.... No. 5,	do.	Nova-Scotia & Welsh Iron,do
Forrester,.....No. 1255	do.	Cochran's Principle.
Armstrong,....No. 12,	do.	Cast on a Core.

A further examination of the iron produced in this country may probably lead to a supply of superior quality, which is now being manufactured on a comparatively small scale; although, where the demand is so uncertain, it may be difficult to feel any security as to a continuance of the necessary attention to it. By keeping a stock on hand at an apparent loss, (a certain loss it would be to a manufacturer) the government will be prepared for emergency, without, when it arrives, interfering with the private enterprise which is working healthily in another direction.

The casting power of this country is very enormous, and might be increased to meet any difficulty, and perhaps even with future advantage to the manufacturer; but the supply of efficient tools (lathes, &c.,) to bore and finish large Guns is necessarily limited, and must remain so, as the demand is special and uncertain.

The frequent intercourse which has been held with some of the most eminent of those who have directed attention to the question of Iron, and the friendly feeling exhibited by all these enlightened men to the endeavours now being made in the government works, render it probable that the vast experience of the country will be brought to bear on a subject, which has been well described as " a mystery."

An improved system of mechanical tests has lately been commenced which promises valuable results as regards Iron Ordnance.

I beg to direct attention to the tables, &c., rather than to the remarks made on them.

August, 1857.

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RULES AND REGULATIONS

OF THE

ROYAL ARTILLERY INSTITUTION.

ESTABLISHED

1838.

REVISED AT ANNUAL GENERAL MEETING, HELD MAY, 1861.

WOOLWICH:
PRINTED AT THE ROYAL ARTILLERY INSTITUTION.
M.DCCC.LXII.

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VICE-PRESIDENTS:

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THE DEPUTY ADJUTANT-GENERAL.

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THE SECRETARY ORDNANCE SELECT COMMITTEE.

THE BRIGADE MAJOR.

FOUR COLONELS OR REGIMENTAL FIELD OFFICERS.

NINE CAPTAINS OR SUBALTERNS.

ONE MEDICAL OFFICER.

CAPTAIN, SECRETARY AND TREASURER.

AN ASSISTANT-SECRETARY.

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RULES AND REGULATIONS.

THE Institution is a voluntary association, supported by voluntary contributions, established for the purpose of affording instruction and information to the Officers of the Regiment on all subjects of professional and scientific interest, and of placing within their reach instruments of a character often too expensive for private purchase.

I. All Officers of the Regiment are eligible to become Members, upon payment of the Annual Subscription of their rank, and an entrance subscription of £1.

II. Officers of the Royal Engineers, and of the Militia Artillery, and professors and masters of the Royal Military Academy, are eligible to become Honorary Members. They may obtain the periodical publications of the Institution, on the annual payment in advance, of the sum of 10*s.* 6*d.*

III. The Annual Subscription of the several ranks, payable in advance on 1st April of each year, shall be as follows:—

	£	s.	d.
General Officers, *ad libitum.*			
Regimental Field, and Superior Officers	1	5	0
Captains	0	16	0
Lieutenants	0	10	0
Medical Officers, according to relative Rank.			

IV. The Commander-in-Chief to be Patron and President of the Institution. The Deputy Adjutant-General, and the Commandant of the Garrison, to be Vice-Presidents. The affairs of the Institution to be under the direction of a Committee, consisting of the above Officers, the Assistant Adjutant-General, the Secretary Ordnance Select Committee, the Brigade Major, and fifteen Officers elected at the Annual General Meeting, of whom four shall be Colonels or Regimental Field Officers, and one Medical Officer, the senior to take the chair. The Medical Officer to retire every two years; one Colonel or Field Officer, and four Members to retire annually, by rotation, and none of these to be eligible for re-election until the expiration of one year after leaving office.

V. A Secretary, having a vote at the Committee, to be selected by the Committee from the Corps at large, to be named to the Deputy-Adjutant-General, and with his approval submitted to the Commander-in-Chief.

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VI. An Assistant Secretary to be selected by the Committee from among the Officers doing duty at Woolwich; not necessarily to be a Member of the Committee, but to vote in the absence of the Secretary, if not a Member.

VII. In case of the death or retirement of the Secretary, or of any Member of the Committee, during the interval of the Annual General Meetings, the vacancy to be filled up by the Committee at their next Meeting.

VIII. The Committee to have the management of the property and funds of the Institution, and to be empowered to make such regulations (consistent with these Rules) as they may from time to time consider necessary.

IX. The property and funds of the Institution to be vested in the name of three Trustees, who shall be authorized and required to make such investments, purchases, and Sales of Government or other Securities, as may be directed by the Committee; the order for such Purchase or Sale being in writing, and signed by the acting President and Secretary of the Committee.

X. In case of the death or resignation of a Trustee, the vacancy to be filled up by the Committee.

XI. A General Meeting of the Members to be held during the month of May in each year, to receive the Annual Report of the Committee, pass the Accounts, elect the Committee for the ensuing year, and decide on such matters as may be brought before them.

XII. A Special General Meeting may be called by the Committee, a notice in writing specifying the objects for which the Meeting is convened, signed by not less than five of its Members, being suspended at the Institution for fourteen days before the day of meeting.

XIII. The Committee shall also be required to call a Special General Meeting, on the written requisition of twenty Members, subject to the same restriction as to notice.

XIV. No alterations shall be proposed, or discussions allowed at the Special General Meetings, on any subjects not specified in the written notice of Meeting.

XV. A Meeting of the Committee to take place on the first Thursday in every month, or on such other days as the Committee shall appoint; five Members to form a quorum.

XVI. The Committee to appoint the days on which Meetings are to be held for the communication of reports, or papers on professional and scientific subjects.

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XVII. No alterations or additions to be made to these Rules, unless a notice in writing, specifying the alteration or addition to be proposed, shall have been suspended at the Institution for fourteen days previous to the General Meeting.

Notice for the information of Members.

Instruction in the following subjects is, through the liberality of Her Majesty's Government, accorded free of charge to all officers—viz: in the French and German languages, by Professors and Masters of the Royal Military Academy; in all descriptions of Surveying, also in Practical Astronomy, by the Assistant Instructor in Surveying, R. M. A. The days and hours of attendance for these and other Classes are notified from time to time.

Members wishing to join any Class are requested invariably to give notice to the Secretary, as also when they cease to attend.

Classes are formed for the pursuit of other studies, such as Mathematics, Drawing, Taxidermy, Photography, Chemistry, &c. The following general Rule is applicable to these, and to all such as may entail expense:—

"The expense of a single Lesson shall, ordinarily, not exceed two shillings. Every Officer, on joining a Class, shall join for a quarter or thirteen Lessons (from the date of joining), and afterwards monthly, and shall pay for every Lesson, whether present or not, unless on duty, or sick, or absent on leave for more than a fortnight."

Officers who may be prevented by duty, or sickness, from attending any Class to which they belong, are requested to intimate the same to the Serjeant Superintendent, before the end of each month. They will otherwise be liable to be charged as if present.

At the discretion of the Committee, assistance is afforded from the general funds in support of all Classes approved by them; such assistance not to exceed one-third of the whole amount.

The following important Regulation applies to all Stations, and can be made available only where the conditions are strictly observed:—

At a Committee Meeting held at the Institution on the 25th May, 1858, it was resolved,—

"That the Institution will bear a share of the expense of Classes for the study of any subject whatever, at any station at which as many as three of its Members will combine for the purpose.

"That the share of the expense borne by the Institution shall not exceed one-third of the whole expense of the Class.

"That the number of lessons shall not exceed three per week.

"That the Class designate one of their number, who will engage to furnish a return of the Members present at each attendance of the Master, and to manage the payments. An account to be sent quarterly to the Secretary of the Institution."

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The following Regulations for the Chemical Studies pursued in the Laboratory of the Royal Artillery Institution, were adopted by the Committee, November 10, 1853, *and are still retained for general guidance.*

1. Each officer joining the class will be furnished at the commencement with the following apparatus, for which he will pay the cost price, viz.,—

	£	s.	d.
1 Blow Pipe	0	2	0
2 Porcelain Dishes	0	1	4
1 Porcelain Crucible	0	0	7
12 Test Tubes	0	1	6
1 Watch Glass	0	0	2
1 Box, Platinum Foil and Wire	0	1	8
1 Tube Cleaner	0	0	3
1 Test Tube Holder	0	1	3
1 Test Tube Stand	0	2	6
1 Crucible Tongs	0	1	3
2 Beakers	0	1	3
2 Glass Rods	0	0	4
1 Sand Tray	0	0	3
2 Glass Funnels	0	0	5
1 Washing Bottle	0	1	0
	0	15	9

2. Additional apparatus constantly required will be supplied by the Institution. Any injury or breakage to be made good at the expense of the individuals causing the damage; if not known, to be borne by the whole class. The above includes all glass bottles containing re-agents, &c. in general use.

3. Larger apparatus of a perishable nature, required by any member for a short time for special purposes, will be supplied by the Institution, the person borrowing such being responsible for its return, in a proper condition, to the person in charge of the apparatus.

4. Any special chemicals not absolutely necessary for the above course, will be furnished by the Institution, and charged at cost price to any member requiring the same.

Of the sixteen tables in the laboratory, one shall be reserved for the use of officers, not being members of the chemical class, who may be desirous of pursuing occasional enquiries. The Secretary to report to the Committee, from time to time, on the working of this arrangement, and to take all necessary precautions against an improper use of the apparatus and chemicals furnished to the officers who may make use of this table.

In forming a Class for the study of Analytical Chemistry, it is intended to confine the general course of instruction, at present, to that branch which bears particular reference to the examination of metals and mineral ores, and all metallic products connected with the arts.

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In carrying out this object it will, therefore, be advisable that the members of the class shall make themselves thoroughly acquainted with the principles of analysis.

The course of study will, therefore, commence with systematic qualitative mineral analysis in its simple form. Each individual thus familiarizes himself with the various tests applied for the detection of metals, both in the solution and in the dry state.

This being accomplished, he will be able to undertake—first, the analysis of artificial mixtures of a more complicated nature, and subsequenty, the examination of any of the more frequently occurring minerals and mineral products.

When the above has, to some extent, been accomplished, he will be prepared to carry on at the same time the study of *quantitative* analysis, commencing with the determinations of simple substances, and afterwards proceeding to apply the knowledge of these and of *qualitative* analysis to the quantitative separation of metals in their compounds, and to the thorough investigation of any substance in which he may feel interested, and which may come before him in a professional way; or in the course of service in parts of the world whose mineral productions may as yet be imperfectly known. In the former class may be specified, gun metal, gunpowder, paints, lacquers, &c., &c.; or any stores bought in the trade, and employed in Her Majesty's service.

The convenience afforded by the excellent arrangements in the laboratory will enable any officer to carry out more extended investigations on any special subjects of importance or interest requiring elucidation.

It must be borne in mind by the members forming the class, that in entering upon this description of study, and in devoting a certain time during the week to laboratory work, under the superintendence of the instructor, they must be prepared to agree among themselves to follow some definite course for a period of three months.

The officers going through the course will have free access to the laboratory to continue their work during the intermediate periods of the instructor's attendance; but it is hoped, will confine themselves to those particular subjects upon which they are engaged, in connexion with the general system of study.

Instruction will not be given to members as a class, although all are working together, but as individuals, so that there will be no difficulty in any one joining, at any period after the commencement of the course.

It may be as well to explain, for the better information of those interested, the present features of the Institution. Besides a Lecture Theatre, where Lectures are delivered on Natural Philosophy, Chemistry, Metallurgy, Mineralogy, &c., it possesses Rooms for Drawing, French, German, Mathematical, and other classes—a Library of professional books, plans, maps, &c. —an excellent Laboratory—Photographic Rooms and apparatus,—Cabinets of Natural History, Mineralogy, and Geology—also a Museum for objects of antiquity and historic interest, including ancient arms and weapons of defence, models, &c. In connexion with the Institution, there is likewise an Observatory

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where opportunity is afforded, to those who may wish to avail themselves of it, of acquiring, under the guidance of one of the Instructors in Surveying at the Royal Military Academy, a knowledge of the use of the more ordinary astronomical instruments. The same Officer instructs in all descriptions of surveying.

A printing press is in constant employment at the Institution: and the Committee earnestly invoke the aid of all Members, who may be so disposed, to contribute Papers upon professional subjects, or on any subjects of military and scientific interest. Such Papers are read at ordinary Meetings; and from them selections are made by the Committee of those that promise to be of more general interest, which are then printed in the "Proceedings," and a copy of which is sent regularly to every Member.

In these "Proceedings" are published also, from time to time, reports of experiments of various kinds, and other matters likely to prove of value to Artillery Officers; and which, from the scattered condition of the Regiment in all quarters of the globe, could hardly reach them with certainty through any other channel. This department, viz: the Professional Papers or "Proceedings" of the Institution, the Committee hope to make increasingly useful by sparing no pains to procure, through the courtesy of the Secretary of State for War, Records of some of the investigations and experiments conducted by the Ordnance Select Committee; and also, from Officers of the Regiment, original papers conveying the results of their own reading, observation, and experience.

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ROYAL ARTILLERY INSTITUTION,
WOOLWICH, JAN. 25, 1854.

THE present sheet is communicated to each station for the information of Members of the Regimental Institution. A copy will be furnished to every Member by the first opportunity; to be hereafter bound up with the 8vo publication of the Proceedings of the Institution.

J. H. LEFROY,
Capt. R.A and Secty.

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MINUTES OF THE COMMITTEE OF THE ROYAL ARTILLERY INSTITUTION.

The following Extracts from Minutes of the Committee of the Regimental Institution are printed for the general information of Members, and will be continued from time to time. They are separately paged, with a view to the future separation of occasional Notices from the Proceedings of the Institution.

By Order,

J. H. LEFROY.

Capt. R.A., Secretary.

OCTOBER 14, 1853.

[2.] RESOLVED—That all Officers withdrawing their names from the list of subscribers, shall, on being subsequently re-elected by the Committee, pay all arrears of subscriptions.

[4.] RESOLVED—That the Committee authorize the use of deposited instruments, by members, when permitted by the Secretary, or Assistant Secretary, to whom all applications for this purpose are to be made in writing.

[10.] RESOLVED—That on the application of five, or more officers, in writing, to be provided with a Master for instruction, at the Institution, or of a less number of officers, at all out-stations and colonies, the Committee is to consider the best means of furnishing assistance for the purpose from the funds of the Institution, or in any other way.

OCTOBER 24, 1853.

With reference to the nature and degree of the assistance to be afforded to classes from the general funds, it was Resolved—

The Committee can lay down no general rule, but will decide upon the degree of assistance to be given in each case, upon its separate merits, the state of the funds, and other considerations.

NOVEMBER 3, 1853.

The Director-General, R. A., being in the Chair, was pleased to sanction the use of the Records of the Select Committee, upon the following terms and conditions :—

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[11.] No extracts or information to be published without approval of the Director General.

Rights of inventors to be consulted, and reference in all doubtful cases to be made to them.

Subjects recently under the consideration of the Select Committee, not in general to be discussed, without the consent of the Director General.

Due reserve and caution to be observed with respect to inventions and improvements, of such a character as to make it an object to guard them from publicity.

RESOLVED—That the Committee gladly avails itself of the permisson to examine the Records of the Select Commitee, with a view to the publication of extracts, under the above conditions.

DECEMBER 2, 1853.

The following letter from the Deputy Adjutant-General was read:

[2.] *Deputy Adjutant-General's Office,*
Woolwich, 24th November, 1853.

SIR,

Having laid before the Master-General your letter of the 9th instant, I am directed by Lord Raglan to acquaint you, for the information of the Members of the Royal Artillery Institution, that his Lordship feels much flattered by the proposition conveyed in their Resolution, carried at the General Meeting, held on the 10th October last, and readily accepts the honor of being Patron and President of that Institution.

I have the honor to be,
Sir,
Your most obedient Servant,
H. D. ROSS,
Dep. Adjt.-General.

Capt J. H. LEFROY,
Sec. R. A. Institution.

JANUARY 5, 1854.

[3.] RESOLVED—That the Secretary communicate to Officers on the Mediterranean stations, that the Committee being desirous of making the Funds of the Regimental Institution as extensively useful to its members as possible, and of promoting the study of modern languages, where they can be acquired most readily, will bear a share of the expense of classes for the study of Spanish, Italian, Modern Greek, Turkish, or Arabic, at any of the Mediterranean stations, at which as many as *four* officers will combine for the purpose.

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The aggregate assistance given in this way, at each station, not to exceed half the amount of subscriptions raised at such station.

Lessons not to exceed three a-week.

Application, signed by all who propose to avail themselves of this arrangement, to be made to the Committee, through the Commanding Officer on the station, stating the proposed terms for instruction, or the terms current at the station.

The class to designate one of their number, who will engage to furnish a return of the members present at each attendance of the master, and to manage the payments. An account to be sent to the Secretary quarterly.

[4.] Secretary reported that, having obtained the previous sanction of seven Members of the Committee, and taken the sense of the donor, he had provisionally invested the sum of £75, being a part of the present of Col. Whinyates, C.B., in the purchase of "Gould's Birds of Europe," at an auction at Messrs. Sotheby's, and recommended its adoption by the Committee, as a suitable memorial of that officer's munificence.

The following extracts from letters were read:—

1. *Mr. R. Hudson, F.R.S., &c., to the Secretary, Dec.* 21, 1853.

* * * "I may congratulate you on getting Gould's Birds of Europe, as they told me at Sotheby's, this morning, that Mr. Gould came into the auction room, after the copy was sold, intending to purchase it at almost any price."

2. *Mr. Gould, F.R.S., &c., to Mr. Hudson.*

* * * "So far from the Royal Artillery Institution having given too much for the Birds of Europe, you may tell your friend that I had a commission (not having a copy left, even for myself) to buy it for one of my subscribers for £80, but I was unfortunately too late. The copy is a good one, and being bound, he has got a bargain."

This splendid work was laid before the Committee. It is in five volumes, folio; the birds coloured after nature, in the highest style of art; and was first recommended for the Institution by a naturalist, as likely to be eminently *useful*, in connection with the Museum.

RESOLVED—The Committee approves the purchase of Gould's Birds of Europe, and the adoption of that work as a part of the present of Col. Whinyates. A suitable inscription to be printed on the covers.

[5.] RESOLVED—The balance of the £100 presented by Col. Whinyates, to be applied to the purchase of a Photographic apparatus; also to bear an inscription, as presented by Col. Whinyates.

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[8.] RESOLVED—That notice be given to Officers, that the Committee will entertain propositions that may be made by Members of the Institution, for aid from its funds towards specific objects, including the loan of books, in aid of particular studies.

[9.] Secretary reported that having waited on the Deputy Adjutant-General, pursuant to a Minute of the Committee, Dec. 2, 1853, [14.] upon the subject of the classes in French and German, he had been requested by Sir Hew Ross, to confer with the Officer directing the Artillery studies of the second Lieutenants, and to report to him in writing, in conjunction with that Officer, the arrangement that both might recommend, as best calculated to place the Masters in those languages upon a satisfactory footing, as regards their relations with the Committee of the Institution; so that the Masters on the one hand, and their classes on the other, might have an appeal in the event of any misunderstanding.

The letter written in pursuance with the above directions, was read, as follows:—

Royal Artillery Institution,
Woolwich, 8th Dec. 1853

SIR,

Having been requested by you to consider and report upon, the best way of securing a due degree of control over the arrangements, under which instruction is given to officers, voluntarily attending at the Royal Artillery Institution, by masters appointed and paid by the Master-General, we have the honor to offer the following suggestions:—

We consider it to be of much importance to maintain the voluntary, self-regulating, and self-supporting principle of the Regimental Institution, unimpaired, to whatever extent the Master-General may now, or hereafter, grant his direct support to the objects with which it was established, by the appointment of Masters in Languages, or in any other branch of professional study.

The advantage of such masters is understood to be an extension of the means of instruction, established for the benefit of second Lieutenants, to the other officers, who may voluntarily wish to avail themselves of it; the regular instruction under authority, to the junior officers, being thus the basis of what can be opened to others.

As then an officer has been regularly appointed to the charge of Artillery studies for the young officers, and with all proper authority over the masters paid to instruct them; it appears to be sufficient to give that officer the authority of an Inspector of Studies, in respect to those conducted under the same, or any other masters paid by the public, by the other classes of officers.

The authority referred to, will have reference, principally, to the regulation of the days and hours of attendance, and the modes of instruction, whenever the master and the class may not be agreed

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upon these points; and the exercise of such an influence in the choice of books and subjects, as may occasionally be desirable, with a view to secure unity of system throughout.

The channel of communication in formal appeals or references, is to be,—first, from the class to the Secretary to the Committee; from the Secretary to the Officer directing Artillery Studies; from the latter to the Deputy Adjutant-General;—second, from the Master to the Officer directing Artillery Studies; from the latter to the Committee, through the Secretary; or to the Deputy Adjt.-General, according to the nature of the case.

In the event of any circumstance arising, or any difference of opinion existing, which cannot be amicably arranged by the combined action of the Committee and the Officer directing Artillery Studies, either of these two parties to be at liberty to refer to the Deputy Adjutant-General.

We have, &c.,

(Signed,) J. H. LEFROY, *Capt. R.A.*,
Sec. R. A. Institution.
W. M. DIXON, *Capt. R.A.*,
D. A. S.

Lt.-Gen. Sir H. D. Ross,
K.C.B., &c.

Note respecting the Museum.

The space available for the purposes of a Museum, consists of two rooms, one 31×31ft., to be appropriated chiefly to Natural History; and one of 34×20ft., intended for Geology and Mineralogy. There are twenty-seven upright glass cases, giving, as at present arranged, an aggregate of 550 feet of shelf accommodation; and eight flat cases, giving an aggregate of 260 square feet, for the display of small objects. In addition to this, space can be found in passages for nine more upright cases, giving an aggregate addition of three, or four hundred feet of shelf, should it be required; and the space under each of the flat cases can be filled hereafter with drawers; so that, on the whole, there is no prospect of the collection out-growing the space available for its accommodation, for many years to come.

The plan of the Museum to be formed, has not yet been finally determined by the Committee, which has sought the advice of several gentlemen eminent in various branches of science, before a decision. Its general nature and arrangement, however, will be determined on principles of utility rather than display. It will, as much as possible, be made complete for purposes of instruction, with especial reference to the opportunities and requirements of Officers of the Regiment. The following appropriation of the cases in the Natural History room, kindly suggested by Dr. J. E. Gray, of the British Museum, will serve as an example:—

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Cases 1, 2, 3,	Mammalia.	Examples of the small species, with a view only to illustrate the principles of classification.
Cases 4, 5, 6, 7,	Birds.	The same, but less restricted.
Case 8,	Reptiles.	
Cases 9, 10.	Fishes, dried, or preserved in spirits.	
Case 11,	Mollusca.	
Cases 12, 13,	Economical Botany.	
Cases 14, 15,	Ethnography, or illustrations of the weapons, utensils, manufactures, &c., of the uncivilized tribes with whom British troops are brought in contact.	

The flat cases he has suggested to devote to Birds' Eggs and Skulls, Land and Sea Shells, Star Fish, Corals, Insects, and miscellaneous small objects.

At the present time (January, 1854) the Institution possesses but slender beginnings, under each of the above heads; and there is scarcely a colony or station from which contributions will not be acceptible, and more particularly of Birds' Skins, Eggs, and Skulls, Corals, Land Shells, Sea Shells, and Insects. Instructions for collecting and preserving these objects will be furnished on demand.

In the Geological department, the Institution possesses a good nucleous for a collection, but is wanting in fossils for the following formations of the British series:—Lower Silurian, Devonian, Triassic, Wealden, Greensand, Chalk, Upper Eocene, and Pleiocene. All colonial fossils will be very acceptable.

In the Mineral department the Institution possesses a good collection of Metallic Minerals, chiefly presented by the family of the late lamented Col. Colquhoun. The series of non-Metallic Minerals, and of hand specimens of Rocks, is far from complete. In each department are many blanks and indifferent specimens, which it is hoped, will gradually be replaced by better ones.

There are very few Land or Sea Shells at present.

The Corals include some fine West Indian and Bermuda specimens, but are far from nearly representing this interesting family.

Of Fishes, Reptiles, Insects, and many families of Mollusca, there are, as yet, but the smallest beginning of a collection.

In concluding this short notice of the present state of the Museum of the Institution, the Committee cannot but point out to their brother Officers, their great and peculiar opportunities for forming a collection at Woolwich, which will combine many interests, both personal and public, with a great degree of scientific value. A body of collectors in most parts of the world—opportunities of free transmission—access to all the sources of information and instruction afforded by the neigh-

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bourhood of London—are advantages such as few other establishments possses. By a system of exchange, such as the Committee hope to establish, not only will all contributions, even of objects already in the Museum, become available for its improvement, but a most useful and creditable part be filled by the Institution,—that of supplying to collectors less fortunately circumstanced, and especially to those provincial museums,—to the developement of which, an eminent scientific man has said, that "we must look, in future, for the extension of intellectual pursuits throughout the land," the means of rendering their collections more available for that high purpose. The means are to be found in every colony, and almost at every station,—for the commonest objects at one, become rarities at another; and the most familiar things to a body of men, whose motto bespeaks their home, may be grateful donations to establishments, whose opportunities are only such as personal zeal can command, with limited connections and still more limited funds. With the hope that a very few years will see the realization of these anticipations, the Committee now calls on Members of the Institution to make the improvement of their Museum an object of exertion and interest.

NOTE—*On the use made of the Institution, since the opening of the new building, in November, 1853; for the information of Members.*

[1.] The Master-General having been pleased to open to all officers, the benefit of instruction in the French and German languages; by directing the masters provided for the junior officers, to attend at the Institution: weekly classes in both the above languages, were formed in October, 1853. Twenty-five officers have availed themselves of the assistance of the French master, and the average attendance in his class has been from eight to nine. Twenty-three officers have availed themselves of the assistance of the German master, and the average attendance in his class has been from eight to nine.

[2.] A Drawing class was formed under the direction of Mr. PRITCHETT, in November, and has been attended by seventeen officers. One-fourth of the expenses of this class is borne by the Institution, three-fourths by the class.—*Min. of Com., Dec.* 2. [10.]

[3.] The Committee having made arrangements with Mr. ABEL, for the instruction of a class in Analytical Chemistry, that gentleman delivered three open lectures, introductory to the subject, in November, 1853; and has since attended twice a-week in the Laboratory. Twelve officers have availed themselves of this instruction, under the rules at p. vi., and the average attendance has been from five to six.

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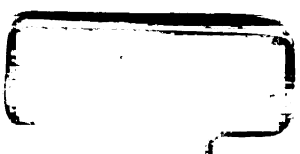

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